Volume 144, No. 7 June, 1957

WORLD OIL

Established 1916 as The OIL WEEKLY

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a quick look at WORLD OIL this month

BUSY OIL MEN: To he'p you put first things first, scan these time saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **Smaller companies and independent operators** in 1956 accounted for 37.6 percent of the crude oil production in the U. S. They had produced 37.9 percent in 1955. Thirty-eight larger companies in 1956 accounted for 62.4 percent of the nation's crude production. That was a somewhat larger proportion than the 62.1 percent they produced in 1955. Standard Oil Company (New Jersey) remained in No. 1 position in 1956, as in 1955, among the individual concerns. Its domestic affiliates provided 6.1 percent of the nation's production in 1956. **Independents Produce 37.6% of Crude Petroleum in U. S.** ..... **Page 98**

☐ **Gulf Oil Corporation and The Texas Company** were the leaders in drilling wells in the U. S. in 1956, as they had done in 1955. However, Gulf went ahead of Texas in 1956, whereas Texas had outranked Gulf in 1955. Standard Oil Company (New Jersey) through two domestic affiliates ranked third in 1956. Standard Oil Company (Indiana) was fourth. Shell Oil Company ranked fifth. Thirty-four larger companies in 1956 drilled only 22 percent of all U. S. wells. Thousands of smaller companies and independent operators together drilled the remaining 78 percent of U. S. wells completed. **Gulf Oil and Texas Company Lead in U. S. 1956 Drilling** ..... **Page 99**

☐ **The important role of independent operators** in U. S. drilling extends into all states and districts. In 1956 they drilled from 60 to 100 percent of the wells in all but a few districts. The exceptions include South Louisiana, North Dakota and California, where deep drilling requires much capital and deters development by smaller operators. **Independents Do Big Part of Drilling in All Areas** ..... **Page 100**

Turn the Page ▸

☐ **Last year 88.4 percent of U. S. refining** was done by 30 larger companies. The remainder of 11.6 percent was accounted for by companies other than the 30. Excluding about one half dozen larger independents from the list of 30 companies leaves major companies accounting for about 86 percent of U. S. refining and independents about 14 percent. The 30 larger companies in 1956 produced only 51.8 percent as much crude as they processed. They bought from other domestic producers and imported nearly one half of their crude requirements. **Independents Do About 14% of U. S. Refining; Majors 86%**.....**Page 101**

☐ **Streamline Your Work Load . . .** There are four deadly time destroyers in every executive's office: The desk—letter box—telephone—and visitor's chair. Turn to **Page 102** for some practical ways to transform these time killers into time savers. **Beware of These Time Killers**.....**Robert E. Johnson**

☐ **The old, tedious accounting methods** are no longer practical in the rapidly expanding oil industry. Increasing government regulation and the growing complexity of tax laws are just two of many factors that are forcing radical changes in accounting procedures. For a timely, detailed account of the new accounting trends, plus suggested ways that you can profit from new accounting techniques, turn to **Page 105. Modern Trends in Oil Accounting**..**Foster Parker**

☐ **Forty-nine oil companies earned 19.2 percent more** in the first quarter of 1957 than in the like period of 1956. Increases were about the same for the international and the domestic groups of companies. Heavy sales of crude and fuel oils to Europe were an important factor. But those sales have diminished in April and May, and oil industry wages are being increased. Consequently, earnings may be up less sharply in the remaining quarters of this year. **First Quarter Earnings Up 19.2% for 49 Oil Companies**... **Page 112**

☐ **For seven years natural gas producers** have tried to shake off the crippling shackles of federal control. Result: The Harris-O'Hara Bill is now in the hopper, complete with two deadly Administration-sponsored amendments. There is general concurrence that this bill would keep natural gas producers in the same untenable position they have occupied since the Phillips Decision. If this is all that seven years of reasoning with Washington legislators can produce, perhaps a new approach is in order. Perhaps that approach should include the consumer. For a timely discussion of the serious problems natural gas producers face, plus the suggested "new approach," turn to **Page 97.**

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at postoffice at Houston, Texas, under the act of March 3, 1879.

Check these West Texas, New Mexico reports . . .

☐ **Active drilling in many fields** of West Texas and southeast New Mexico will result from scheduled large expansion of oil and gas pipe line outlets from the region. The Permian Basin already has outlets for 2 million barrels of crude per day. Planned new crude oil pipe lines will provide an additional capacity of ½ million barrels daily. Substantially more outlet for natural gas also is due to be provided. To meet anticipated greater demand for both oil and gas, the producers of the Basin henceforth will carry out vigorous exploratory and field development drilling throughout the region. Turn to **Page 120. What's Ahead in Permian Basin** .....**L. J. Logan**

☐ **A look at present activity shows that** the Permian Basin contributes more than one-fifth of the nation's oil, which amounts to one-tenth of the world's oil needs. Output from this high-activity region now averages almost 1,700,000 barrels a day, or more than double the volume being taken ten years ago. This great basin is also the scene of high drilling activity, with this year's wells topping last year's record by almost 20 percent, and the outlook continues bright. See **Page 123. Current Activity in the Basin**.....**Cecil W. Smith**

☐ **Faster drilling rates** have resulted in most cases from the use of low solids drilling fluids. Turn to **Page 125. New Drilling Fluids in the Permian Basin** **Harris A. Oehler**

☐ **New Drilling Records Set.** Three air and/or gas-drilled wells have improved on the record of the first mud-drilled well by 1000 hours of rotating time and more than 125 bits and trips. These controlled tests also brought out innovations in air drilling that will further advance this new drilling medium. Turn to Page 130 and read how these records were set and what practices and equipment were used. **Air Drilling in Val Verde Basin**.....**R. W. Horton**

☐ **Costly fishing jobs** for drill pipe are the results of many factors. One of these can be a poor or haphazard method of determining the service life of the string and using it beyond its useful age. Evaluating the exact service life of each joint is almost impossible. But one operator has devised a system of visual inspection and rigid inventory control that has reduced considerably operational failures in his strings. See **Page 134. What's the Service Life of Your Drill Pipe?**..... **Paul D. Schaffer**

☐ **Drill collar selection** comes in for special consideration in the well consolidated limestones and dolomites of the Permian Basin where heavy drilling weights and low rotary rpm are the accepted practices. What O.D. sizes are used? What material are the collars made from? How many are used? What are the popular joint sizes? What are the main causes of failures? These and other questions are answered in the article beginning on **Page 140. Drill Collar Practices in Permian Basin**.....**William R. Bachman**

☐ **Spraberry Clear Fork production** has made a material contribution to the oil business . . . both technically and monetarily. The story of its discovery, development and present production activity is an interesting part of the West Texas oil picture. See **Page 158. The Second Spraberry Boom**.....**Leroy Gideon**

☐ **Pressure maintenance progress** on the largest unit ever formed has been watched with interest since its origination more than four years ago. Facts and figures are now available on the project that could be a model unit. Engineering skill and close cooperation are making.....**Progress at SACROC**.....**Page 152**

☐ **Case histories on 16 wells** refractured with large-volume high-velocity treatment show an average payout of 36 days. This would indicate that such treatments can be successful in the Spraberry Trend area of West Texas. For details, see **Page 166. Spraberry Refracturing Proves Successful**.....**Steven Gerolde**

EXPLORATION ARTICLES

☐ **There is disagreement** as to the mechanics controlling the formation of closures against depositional faults in the Gulf Coast area but it appears that they are due in part to drag against the fault resulting from the incompetent nature of the sediments. For details, turn to **Page 179. A Neglected Objective**..... **Gerry Bernatchez**

☐ **A new seismic profile printer,** developed by Gulf Research & Development Company, furnished a profile section bearing close resemblance to a geologic cross-section. As a result, the seismic picture of the entire profile can be absorbed at a glance. **Looking Inside the Earth.** .....**Page 182**

☐ **The SW flank of the Williston Basin** is one of the most important remaining frontiers for exploration of the Rocky Mountain province. Turn to **Page 184. Oil Possibilities in Williston's SW Flank**..**A. Rowland Boucher, Carl A. Moritz and Wayne E. Swearingen**

DRILLING ARTICLES

☐ **The final installment** of Prof. S. J. Pirson's series on log interpretation includes both Parts 3 and 4. Professor Pirson takes up oil wet rocks of intergranular porosity and rocks with multiple type porosity. For proper interpretation in either of these two types of reservoir rocks, core and production data are very desirable, but through proper use of logging tools accurate values of reservoir factors can be ascertained. **Formation Evaluation by Log Interpretation**.....**Page 193**

☐ **Operations in low formation** pressure workover areas are normally undertaken with cable tools. Now the use of fluid loss additives has made the use of reverse circulating rotaries an economically successful operation. Some of these case histories are presented in the article beginning on **Page 199. Fluid Loss Additive Aids Workover Efficiency**.....**J. G. Davis, Robert T. Means and Paul W. Whitaker**

☐ **Slim hole rigs are gaining favor** with operators and contractors alike in shallow drilling areas where highly portable rigs can operate with decreased drilling and completion costs. Turn to **Page 207** to see how slim hole rigs are assembled and operated. **Advantages of Slim Hole Drilling in Tri-State Area**..... **Arnold F. Lewis**

☐ **Miscellaneous fishing tools** are varied and numerous, but some through years of successful usage have become more or less standard. Spears, overshots, grappling devices and junk baskets all play an important part in getting junk and pipe out of the hole as quickly as possible. When the fish is large and cannot be backed off then it is necesary to cut. These tools and their applications are discussed in the fifth part of the series on Fishing Tools and Techniques, **Page 213. Catching and Cutting Tools**.....**Weldon L. Medders**

☐ **Rig-time is safety-time.** Accidents are costly—both in suffering and in time and material. Why and how they happen and steps to be taken to insure that these accidents do not re-occur are covered on **Page 220. Accidents on the Rig—A Case History**..... **Anthony Gibbon**

Turn the Page ▸

THIS MONTH . . . *continued*

PRODUCTION ARTICLES

☐ **Increasing oil recovery** by alternately producing and repressuring non-homogenous oil reservoirs being gas-cycled has merit. Available information appears to substantiate the practicability of the proposed method and its application to different types of reservoirs. For more information on a process that promises success in both primary and secondary recovery, turn to **Page 223. Batch-Type Cycling Recovers More Oil**.... **Alton B. Cook**

☐ **What is automation?** The idea of complicated electrical circuits has too often troubled field men. Here is a simple explanation of the basic units or "building blocks" which can be found in a lease control system. Anyone concerned with automation will find this article helpful. See **Page 228. Simplifying Automatic Lease Control Systems**.....**Jack W. Allen** and **Hugh A. Saye, Jr.**

☐ **Evaluating potential profit or loss** to be expected from drilling a well is a recurring task for the development geologist or engineer. For a fast and simple evaluation within the bounds of your data accuracy, try the nomograph on **pages 234 and 235. A Quick Look at Your Production Economics**.....**G. G. Tubb**

☐ **Attention all producers . . .** if you are waterflooding or ever contemplate it, you can't afford to pass up this article! It could mean the difference between success and failure. It's a well prepared and easily read presentation (**Page 238**) that will help put the odds in your favor by showing you why . . . **Water-Flood Prospects Need Engineering Analysis**..... **W. W. Wilson**

☐ **The cure-all for secondary recovery** is not fracturing. Each field and each well is a separate problem. There are indications, however, that nature can use a hand to penetrate that last few feet around the well bore. The Pure Oil Company took advantage of this situation on some of its wells in Nowata County, Oklahoma, with satisfactory results. See **How Fracturing Can Help Flooding**.....**Jesse E. Wyrick**

INTERNATIONAL ARTICLES

☐ **What will the Sahara desert oil discoveries mean?** To France, perhaps the removal of its pressing need for importing more than 90 percent of its domestic crude requirements. And to the world of oil, it may mean a brand new major supply of crude to Western markets. **Sahara Potential May Reach 450,000 BPD Level** .....**Page 261**

☐ **An aerial photographic and magnetic survey** of more than 35,800 square miles is being completed for Cuban Stanolind Oil Company. Flying was completed in record time and compilation was being finished. New techniques to overcome bumpy air and to avoid inaccuracy wrought by magnetic storms were used. For the story of another important chapter in Cuba's advancing oil history, see **35,800-Square-Mile Aerial Survey in Cuba Completed**.....**Page 264**

Specialized oil publications of THE GULF PUBLISHING COMPANY, 3301 Buffalo Drive, Houston 19, Texas; Box 2608, Houston 1, Texas. Cable Address: GULFPUBCO.

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ABP

SUBSCRIPTIONS

R. M. DE Sombre, Circulation Manager, P. O. Box 2608, Houston, Texas, U. S. A.

Single copies 50 cents (except special issues). Double prices for single copies more than one year old. Subscription price: domestic and foreign, $2 a year.

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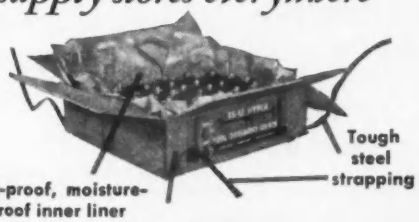

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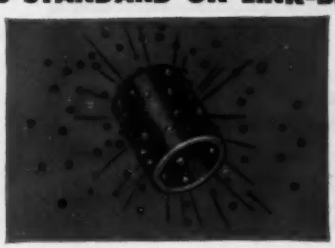

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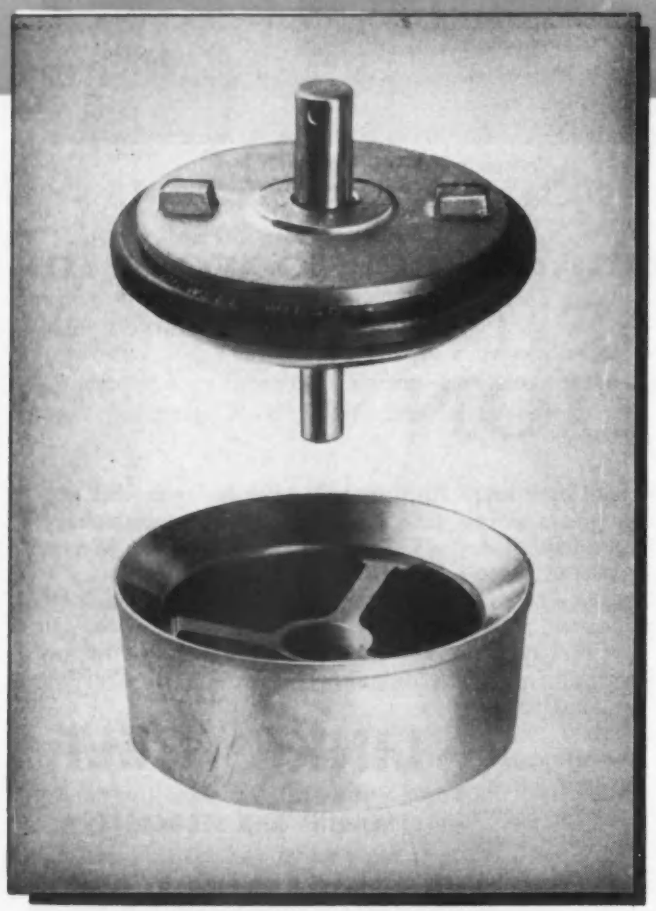

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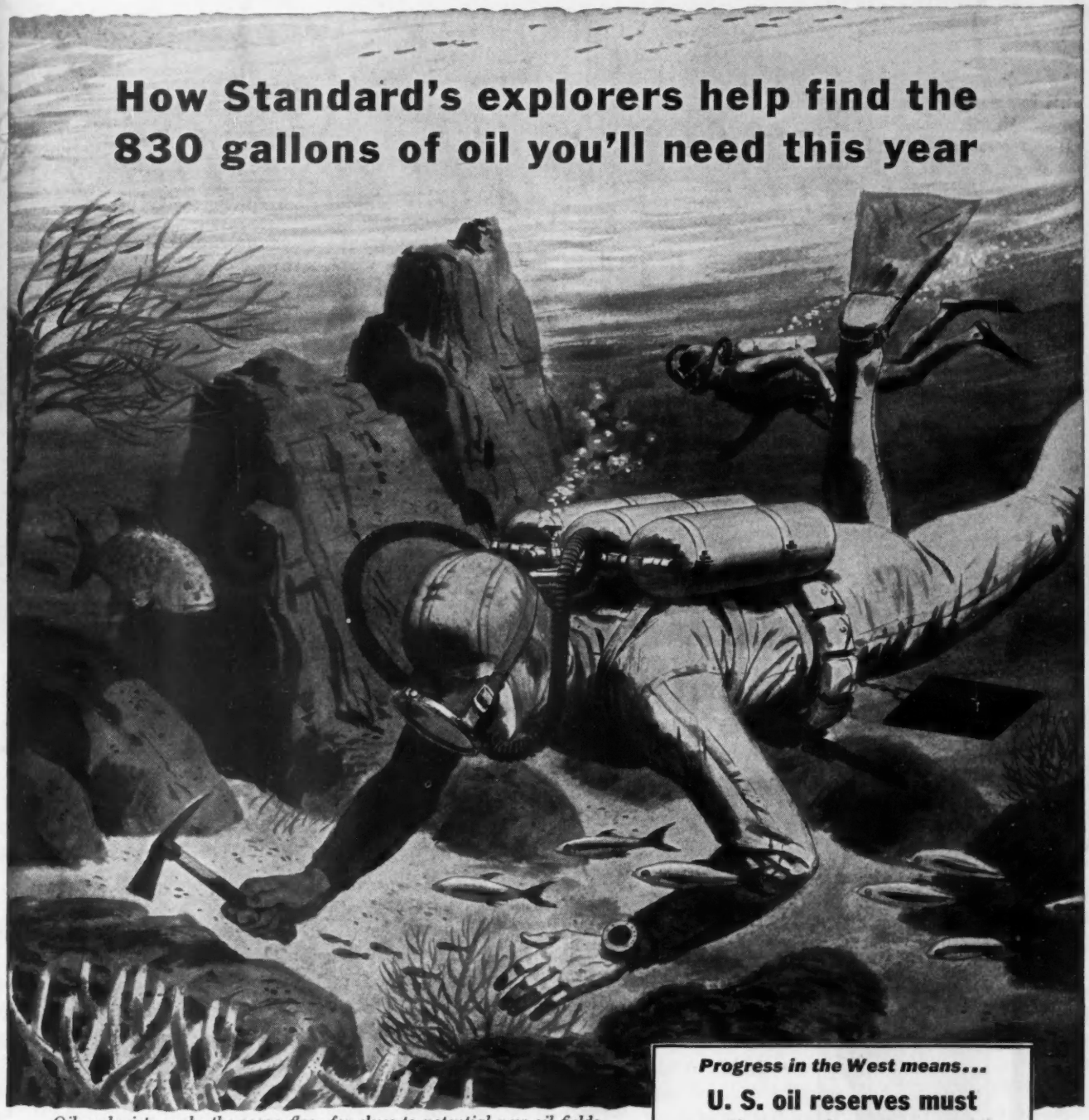

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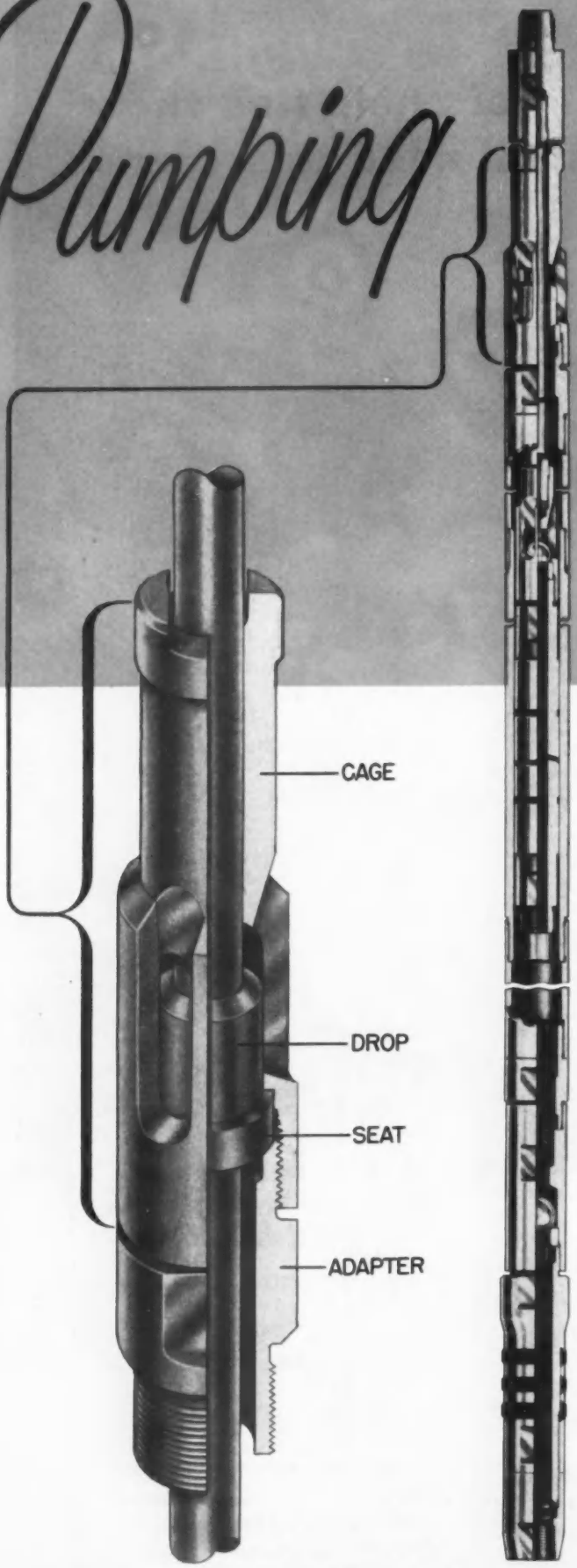

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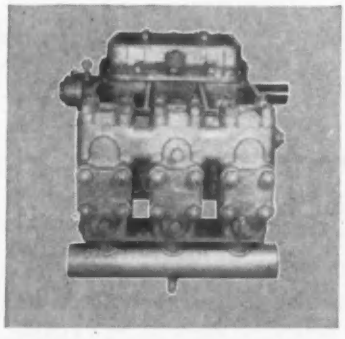
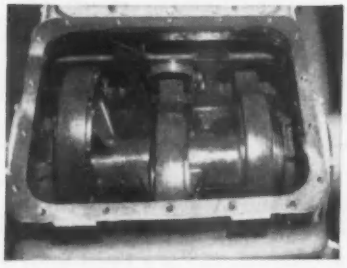
NEW Gardner-Denver well servicing pump delivers up to 6000 psi

New Gardner-Denver PE-5 single-acting triplex plunger pump for oil well servicing. Length, 69¼″; width, 47″; weight, 2990 lb. Maximum ratings on intermittent service: 130 bhp, 290 rpm, 1336 gpm, 1430 psi. Plunger diameters from 3″ to 1¾″ give a range to 32 gpm at 6000 psi.

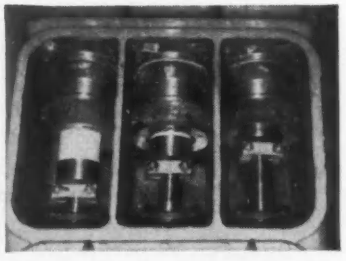


One-piece cast steel fluid end withstands peak loads. Valves individually accessible. Suction and discharge connections made from either or both sides.

Mounted positive oil pump driven directly from eccentric shaft assures lubrication to power end parts even at reduced speeds.



Exclusive Gardner-Denver eccentric drive, including one-piece connecting rods with bronze liners and pin bushings, helps eliminate major source of failures.



Hardened steel, ceramic, and special service plungers are available. Complete plunger and stuffing box assembly can be removed and repacked as a unit.

This new heavy-duty pump is built by Gardner-Denver especially to meet oil well servicing requirements. It has power and dependability to pay off for you. It's now in production. For details and prices, consult your distributor or the Gardner-Denver oil field office near you.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

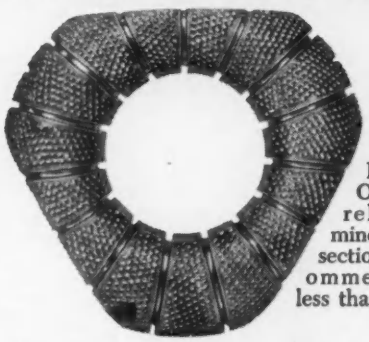
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario
Gardner-Denver Export Division, 233 Broadway, New York, N. Y.
Oil Field Offices: Dallas, Houston, Tulsa, St. Louis, Los Angeles, New York, Pittsburgh, Denver, New Orleans, San Francisco, Kansas City, Winnipeg, Edmonton

For more data on advertised products, use Readers' Service Cards, last page.

announcing the all-new

D&S TRI-DIA diamond core bit!



Relation of bit OD to core barrel OD determines cut-a-way section – not recommended when less than 1¼".

Check these outstanding features:

- Designed for safety.
- Reduced OD wall contact, similar to Tri-Cone Rock Bit.
- Reduces mud wall cake sticking hazard.
- When making trip, eliminates swabbing – hydraulic action.
- Minimizes junk iron hazard – allows washing out large pieces.
- Readily washes out cavings to bottom.
- Largest measurable diameter materially less than diameter of hole it will cut. (Special Bit Breaker required.)

FOR PEAK PERFORMANCE bit must be designed for each individual job. This information is necessary – (a) type mud, (b) circulation rate, (c) formation and characteristics, (d) rock bit footage, (e) available fluid h.p.

A winning combination:

The revolutionary new D & S Tri-Dia diamond bit, combined with the famous D & S core barrel give coring efficiency PLUS! Rugged core barrel construction and design assure full core recovery. Safety joint, core wedge indicator and fully enclosed lubricated bearings are featured. A minimum of core exposure to fluid circulation eliminates core washing.

WRITE OR CALL TODAY! One of the D & S sales engineers will call on you to show tremendous TRI-DIA Bit and Core Barrel advantages.

Drilling & Service

TRUCO DIAMOND BITS

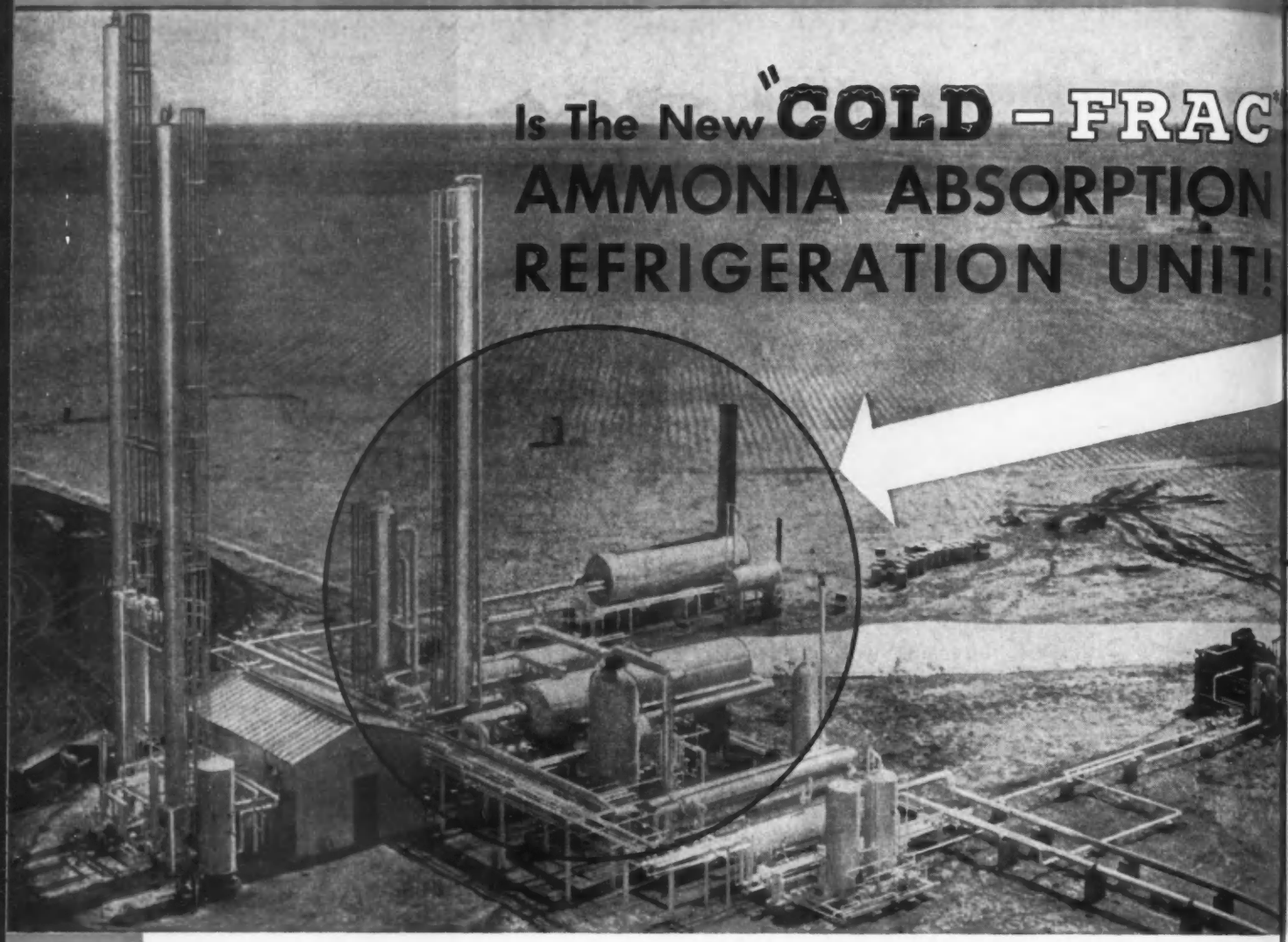
INC. | DIAMOND DRILLING EQUIPMENT

6210 NORTH CENTRAL EXPRESSWAY | DALLAS, TEXAS

OFFICES IN ALL PRINCIPAL OIL AREAS

Ultra Fine Diamond Equipment for the Oilfield

The "Heart" Of This BS&B



Is The New "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION UNIT!

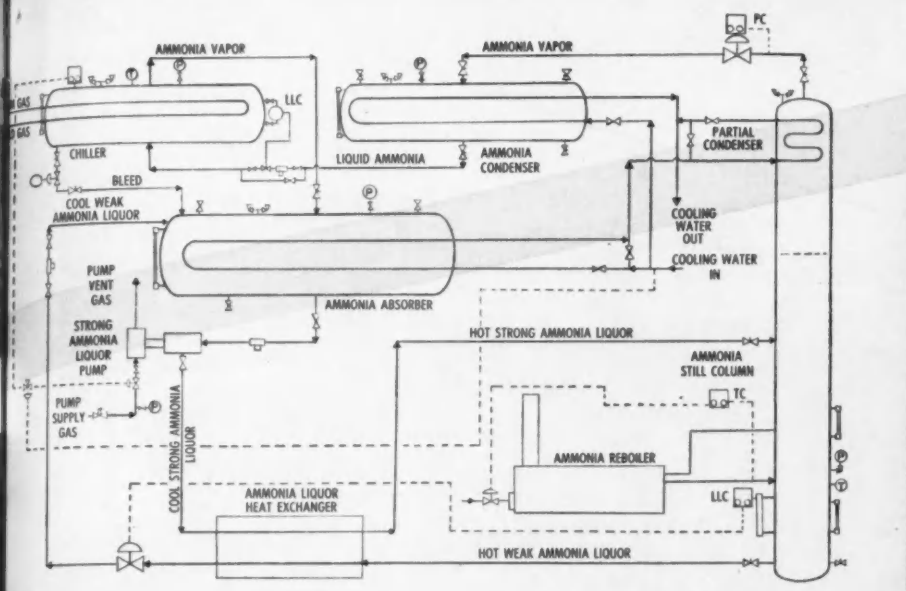
Ammonia Absorption Refrigeration Yields Low Dew Point Gas And Salable Liquid Hydrocarbons

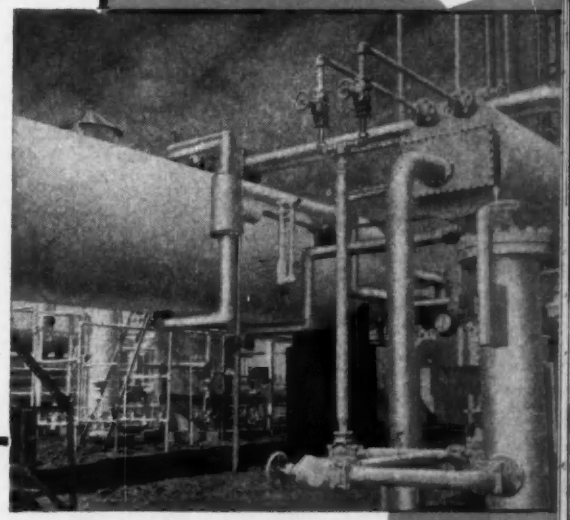
Early this year, Excelsior Oil Corp. (a subsidiary of Kansas-Nebraska Natural Gas Company, Inc.) put a new gas gathering plant on stream at Tyrone, Oklahoma. This plant, employing the new BS&B "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION Unit, is located on a major gas transmission line and was entirely designed, manufactured and constructed by BS&B on a "turnkey" basis. Here, in brief, are the important facts:

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Your BS&B Man will be glad to give you detailed information on the new BS&B "COLD-FRAC" Ammonia Absorption Refrigeration Unit. Or, you may write to...

"Turnkey" Gasoline Plant . . .





THE OBJECTIVES:

1. To Achieve Maximum Dehydration Of The Gas Stream.
2. To Lower Hydrocarbon Dew Point To 0° F.
3. To Economically Extract Maximum Amount Of Salable Liquid Hydrocarbons Without Lowering Gas BTU Value Below Acceptable Limits.

The Company asked BS&B Engineers to analyze the objectives, and to recommend a suitable type plant.

THE RESULTS:

The low temperature plant was built "turnkey" by BS&B, incorporating Ammonia Absorption Refrigeration. This resulted in low water dew point, positive hydrocarbon dew point and the recovery of salable liquid hydrocarbons.

Ten Advantages Offered By BS&B "COLD-FRAC" Ammonia Absorption Refrigeration Units:

1. **Entirely Self-Operating.** Automatically Adjusts to Load Changes.
2. **Low Initial Cost.** Unit Is Entirely Skid-Mounted Except Ammonia Reboiler. Outside Construction — No Buildings Required.
3. **Low Cost Maintenance.** Liquid Pump Is the Only Moving Part.
4. **Operating Costs Vary** in Direct Proportion to the Load.
5. **Lower Operating Temperatures** Do Not Materially Decrease Capacity.
6. **Completely Closed System.**
7. **Chiller "Slop Over" of Liquid Refrigerant Causes No Problem.** (There is no compressor to cause worry about liquids in the suction.)
8. **Oil Lubrication Eliminated.** No Oil-Refrigerant Problem.
9. **Vibration Free.** No High Speed Reciprocating Machinery to Mount.
10. **Experts Are Not Required** to Operate and Maintain the Unit.

OTHER APPLICATIONS

BS&B Ammonia Absorption Refrigeration Units are applicable to any process that requires temperatures below ordinary atmospheric level, including all steps in the complete production cycle from the lease through the central plant to the refinery.

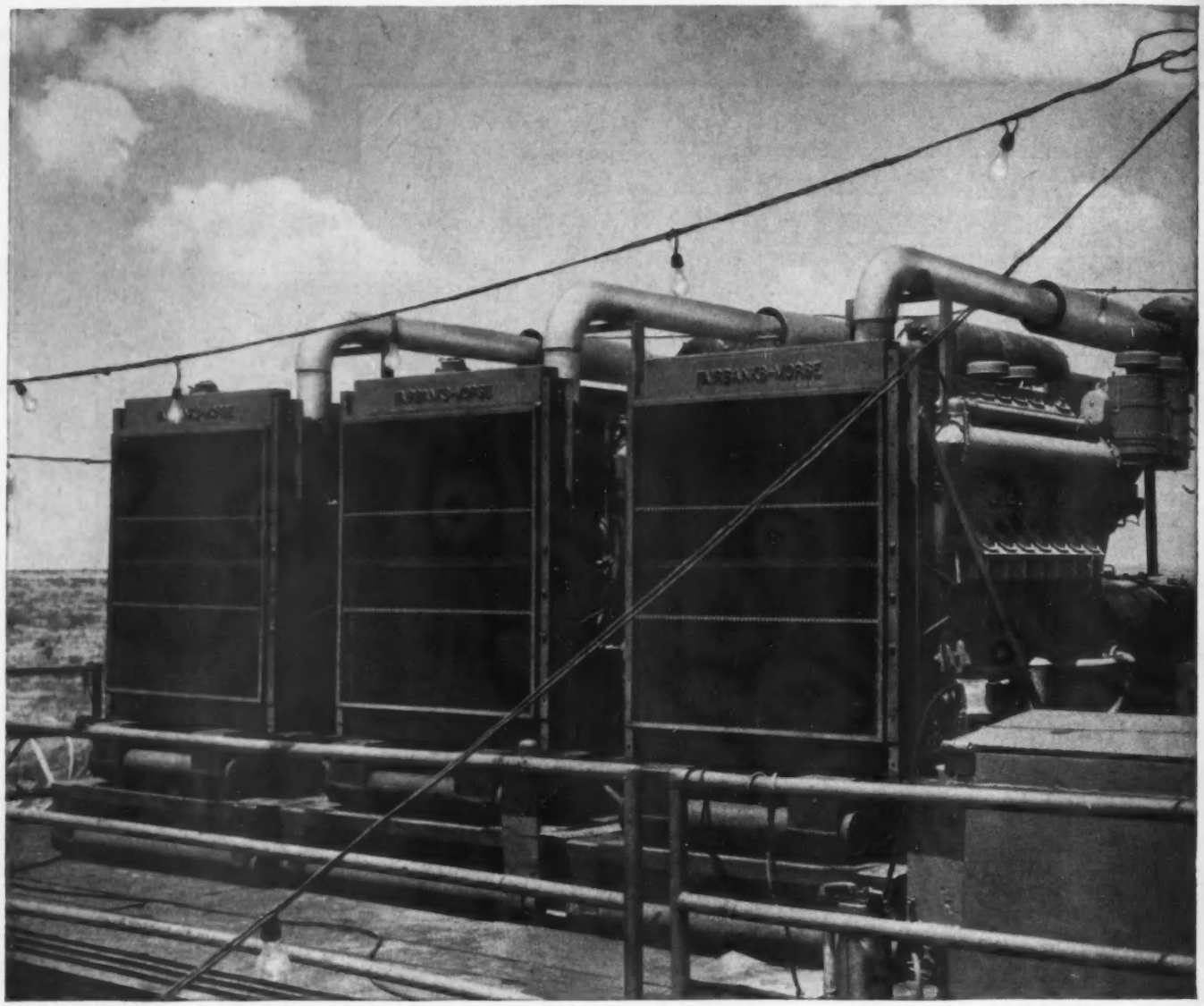
These units are constructed for heavy duty, continuous 24 hour-per-day, 365 day-per-year operation. Available in eleven standard sizes—with nominal capacities of up to 200 tons—these units have been designed to provide trouble-free, completely automatic operation under all conditions with minimum maintenance expense. Units larger than 200 tons in size offered on request.

* "COLD-FRAC" is a trade-mark of Black, Sivalls & Bryson, Inc.

BLACK, SIVALLS & BRYSON, INC.

Oilfield Equipment Division, Dept. 98-1

P. O. Box 1714 Oklahoma City, Okla.



The **38-F-90** is a drilling engine

Here's Why

Fuel? . . . The 38-F-90 burns gas, propane or liquid fuel with the inherent economies of diesel compression.

Hp. rating? . . . Continuous slush pump rating is 75 hp. per cylinder, and the six sizes (4-5-6-7-8-10) include the right engine for any job between 300 and 750 hp. Whether four cylinders or ten, it's the same engine, the same width and height, the same operating technique. Many parts are interchangeable.

Speed range? . . . The 38-F-90 is rated for continuous heavy-duty service from 450 to 1200 RPM. This range is right for any mechanical, hydraulic or electric drive.

Give and take? . . . The 38-F-90 is a Fairbanks-Morse engine. This means that it will give service and take punishment. Its simplicity and its stamina are the result of its Opposed-Piston two-cycle design and its all-steel welded frame.

This all adds up to why the Fairbanks-Morse 38-F-90 is a *drilling* engine. Fairbanks, Morse & Co., Oil Field Division, Chicago 5, Illinois.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

OIL FIELD EQUIPMENT • PUMPS • SCALES • ELECTRIC MOTORS • GENERATORS • LIGHT PLANTS • DIESEL, DUAL FUEL, GAS AND GASOLINE ENGINES MAGNETOS • DIESEL LOCOMOTIVES

New Coupling Method Speeds Make-up of A-C Pipe

Pipe ends slide quickly into place over tapered rings. Rings expand under fluid pressure.

Rapid make-up of asbestos-cement pipe is possible, even in rain, snow, or wet trenches, with the new "Century" Fluid-Tite Coupling.

Its unique hollowed rings exert their greatest sealing pressure against pipe and coupling *when the pipe is filled.* The compressibility of these rings reduces resistance to insertion of the pipe during make-up, offers maximum cushioning against shock once the pipe is laid.

The combination of lightweight "Century" A-C Pipe with fast Fluid-Tite Couplings is ideal for quick field installation with minimum crews and equipment. With "Century" there is no problem of maintenance or deterioration even in areas of selective corrosion.

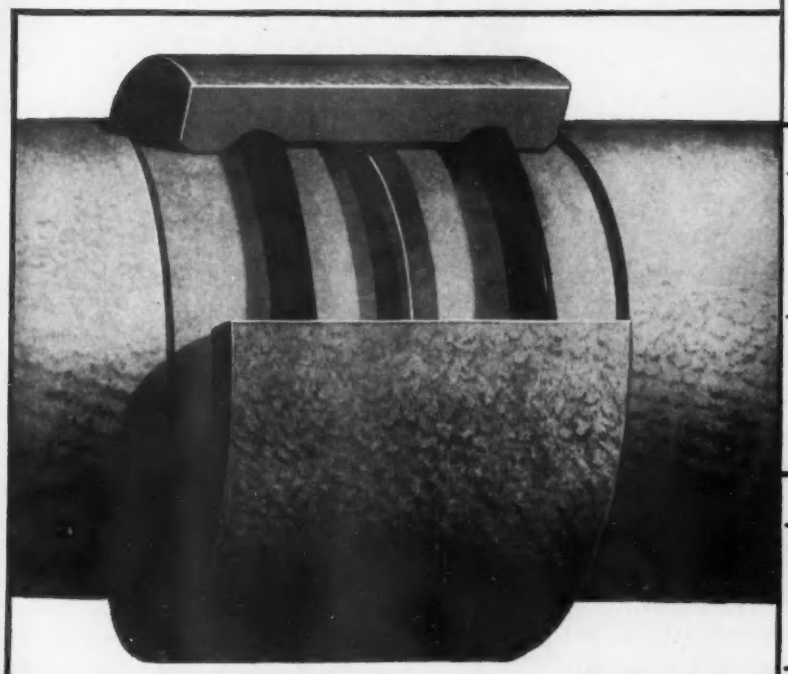
Full details without obligation. Write or call your nearest South Chester Tube Company office.

© 1956

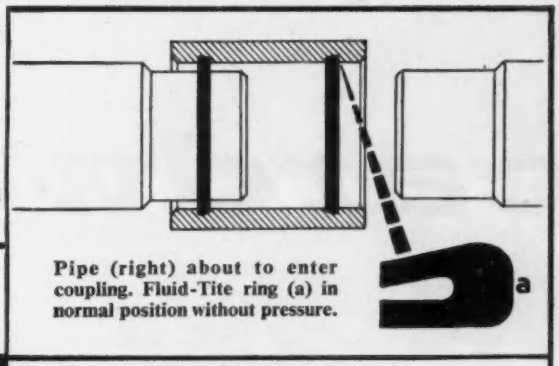
SOUTH CHESTER TUBE COMPANY

1418 SOUTH PENN SQUARE, PHILADELPHIA 2, PA.

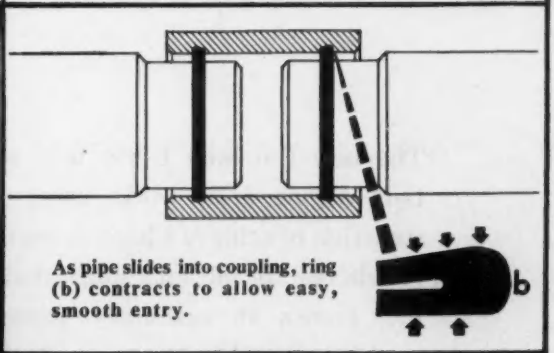
Houston 2, Texas	Fort Worth 2, Texas	Tulsa 3, Oklahoma
420 Esperson Bldg.	1605 Oil and Gas Bldg.	Hunt Building
Phone: FAirfax 3-1153	Phone: EDison 2-8871	Phone: CHerry 2-1284



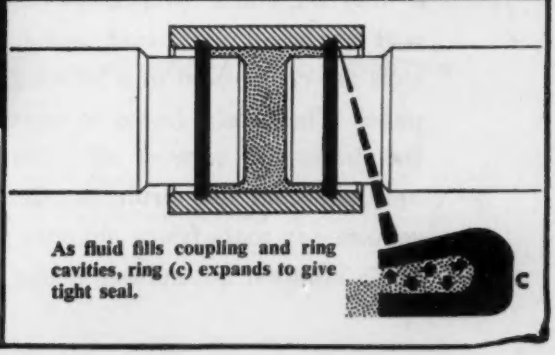
"CENTURY" ASBESTOS-CEMENT "FLUID-TITE" COUPLING (sectioned). Make-up speed results from holes in tapered "Fluid-tite" sealing rings. Holes permit rings to compress, allowing pipe ends to slide into coupling easily and without a special puller.



Pipe (right) about to enter coupling. Fluid-Tite ring (a) in normal position without pressure.



As pipe slides into coupling, ring (b) contracts to allow easy, smooth entry.



As fluid fills coupling and ring cavities, ring (c) expands to give tight seal.

NEW DESIGN!

NEW ENGINEERING!

tailored to fit your needs

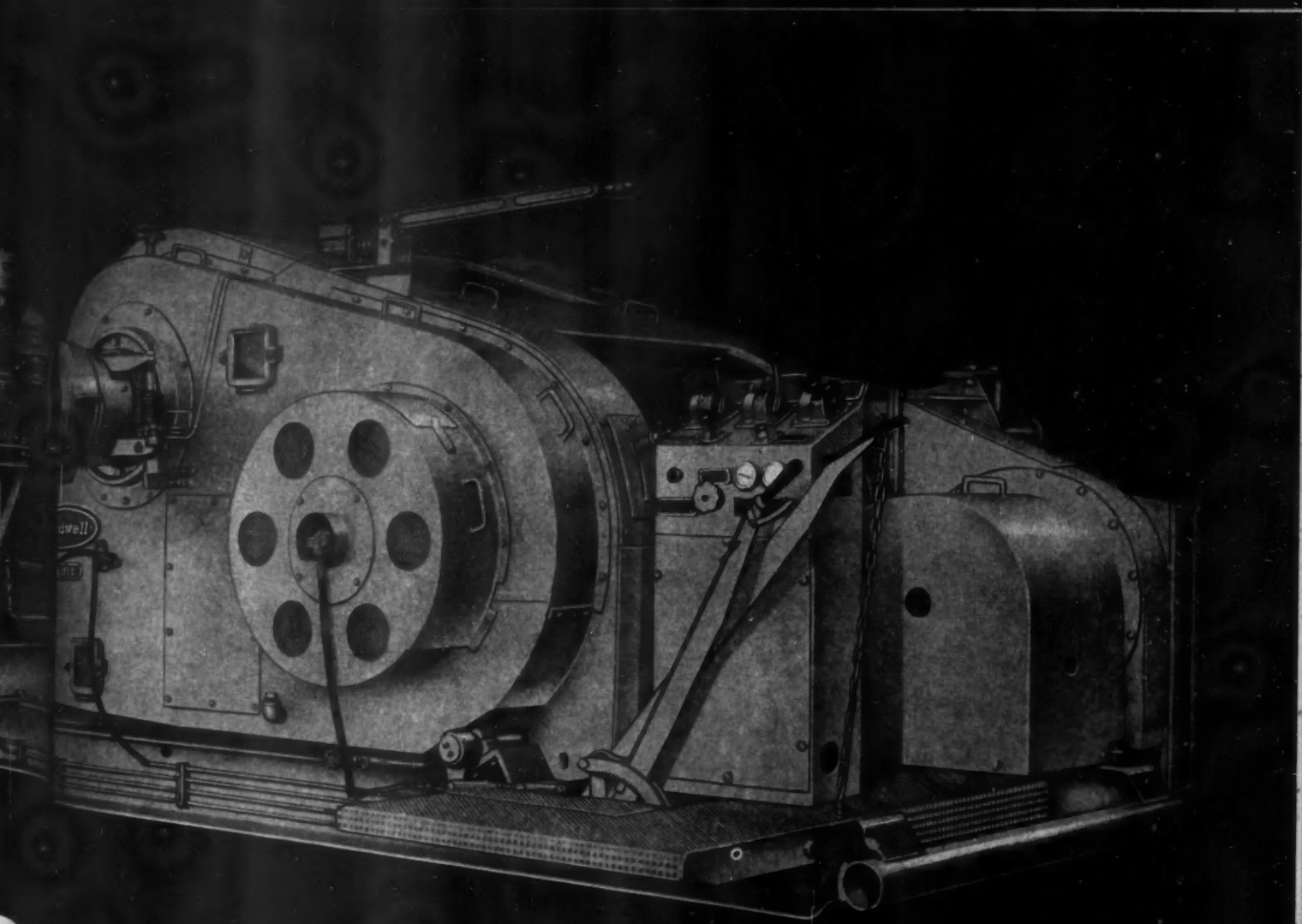
THE *NEW*

cardwell L-350

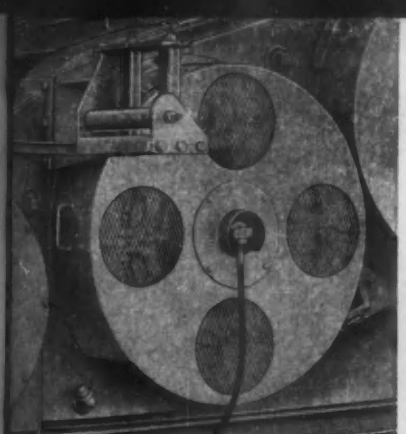
The new Cardwell L-350 is a compact single or twin engine draw works using plate frame construction to achieve a high strength-to-weight ratio. All drives are oil bath lubricated for longer chain life. Here's an extremely versatile unit that is readily adaptable to various trailer mountings as well as conventional skid masts. Single lever controls are centralized in a forward mounted control panel. The safety factor is increased by allowing the driller full view of all drilling operations. An optional sand line drum is offered that does not require any main frame changes. The Model L-350 has a nominal horsepower rating of 350.

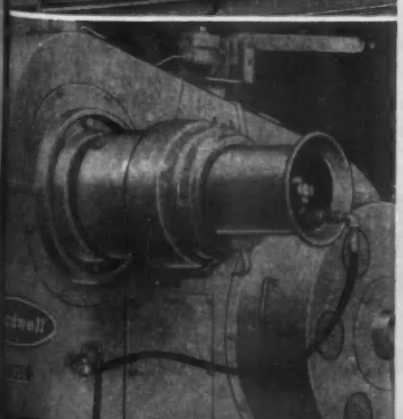
Job-tailored Features

- PLATE-FRAME CONSTRUCTION for high strength-to-weight ratio.
- CHAIN DRIVES—all oil bath lubricated.
- SIMPLIFIED SINGLE LEVER CONTROLS for safe, convenient operation.
- FRICTION CLUTCHES — Fawick's newest design — exterior mounted.
- HYDROMATIC BRAKE (optional) 15-inch double rotor mounted with a separate Friction Engaging clutch.
- ROTARY BRAKE—Air Controlled—quickly and smoothly stops and holds rotary table.



TORQUE CONVERTER DRAW WORKS





Externally mounted clutches

Maximum operating efficiency is provided by Fawick VC (ventilated type) clutches mounted in each end of a Double End Drum Drive.

Oil bath chain drives

Oil bath lubrication to all drives. This efficient oiling system assures positive lubrication and long life for all chain drives.

FOR FULL INFORMATION CALL YOUR

NEAREST CARDWELL REPRESENTATIVE

cardwell MANUFACTURING COMPANY

BOX 2001, WICHITA, KANSAS, U.S.A.

C-6-7

WAUKESHA

Engines and Power Units FOR GAS COMPRESSORS

Typical Waukesha-driven compressor application (Model WAKU engine) in Southwest

● You can select exactly the right power to meet your gas compressor needs because the Waukesha Engine line is complete. All the proven features that give long engine life . . . the ability to withstand overloads . . . low upkeep and high economy of operation . . . are built-in. Materials, design and operating characteristics—all result from Waukesha's over 50 years of experience in fine engine building. You cannot buy a better compressor engine.

NATURAL GAS ENGINES FOR COMPRESSOR SERVICE				ENGINE	API BRAKE HP. AT SPEEDS INDICATED							
Model	Bore & St.	Displ.	Installation	MAX. HP.	800	900	1000	1100	1200	1400	1600	1800
140-GZB	4⅜ x 5½	554	No radiator or fan	142 @	44	....	55	....	65	75	84	92
			With radiator, fan	1800	43	....	53	....	62	71	79	85
145-GZB	5⅜ x 6	817	No radiator or fan	214 @	65	....	81	....	96	110	125	139
			With radiator, fan	1800	62	....	77	....	90	103	116	129
WAKB	6¼ x 6½	1197	No radiator or fan	260 @	85	....	110	....	134	153	169	
			With radiator, fan	1600	82	....	106	....	127	144	157	
NKRB	7 x 8½	1905	No radiator or fan	335 @	155	170	187	203	218			
			With radiator, fan	1200	149	163	176	189	199			
LRORB	8½ x 8½	2894	No radiator or fan	465 @	228	250	268	283	302			
			With radiator, fan	1200	221	242	257	271	286			
LRZB	9⅜ x 8½	3520	No radiator or fan	568 @	273	304	330	351	369			
			With radiator, fan	1200	265	294	316	332	343			
VLROB	8½ x 8½	5788	No radiator or fan	890 @	435	481	524	557	579			
			With radiator, fan	1200	427	470	510	541	559			

Send for descriptive Bulletin No. 1699

API ratings

NOTE: All models are 6-cylinder except Model VLROB (12-cyl.) and have aluminum pistons, counterbalanced crankshafts, and vibration dampeners.

WAUKESHA MOTOR COMPANY • WAUKESHA, WISCONSIN

New York • Tulsa • Los Angeles

346

For more data on advertised products, use Readers' Service Cards, last page.

After 15 months' service... Gathering lines of NATIONAL* PVC PIPE show no paraffin build-up!

In October 1955, the TXL Oil Corporation installed a 2,800-foot gathering line of USS NATIONAL Polyvinyl Chloride Pipe in the Permian Basin, 12 miles south of Odessa, Texas. Metal pipelines, previously used for this application, had required frequent steaming out to remove paraffin build-up which plugged the line.

Upon inspection of the NATIONAL PVC line, in January 1957, after 15 months of continuous service, the following was revealed:

a. Despite heavy, year-round use, the PVC line showed no evidence of paraffin build-up.

b. There had never been any reduction in flow.

c. The engineers responsible for installing the NATIONAL PVC line agreed that it had definitely solved a paraffin problem. They recommended it for future similar installations.

This 2,800-foot line of NATIONAL PVC Pipe was laid in *1¾ hours.* Average service temperature is 75°-80°F. Pressures average from 30 to 40 pounds.

NATIONAL Polyvinyl Chloride Pipe is available in two types, in sizes ½" to 6" inclusive and in Schedules 40, 80 and 120.

NORMAL IMPACT—for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

HIGH IMPACT—for installations requiring excellent chemical resistance and a high degree of toughness even at low temperatures.

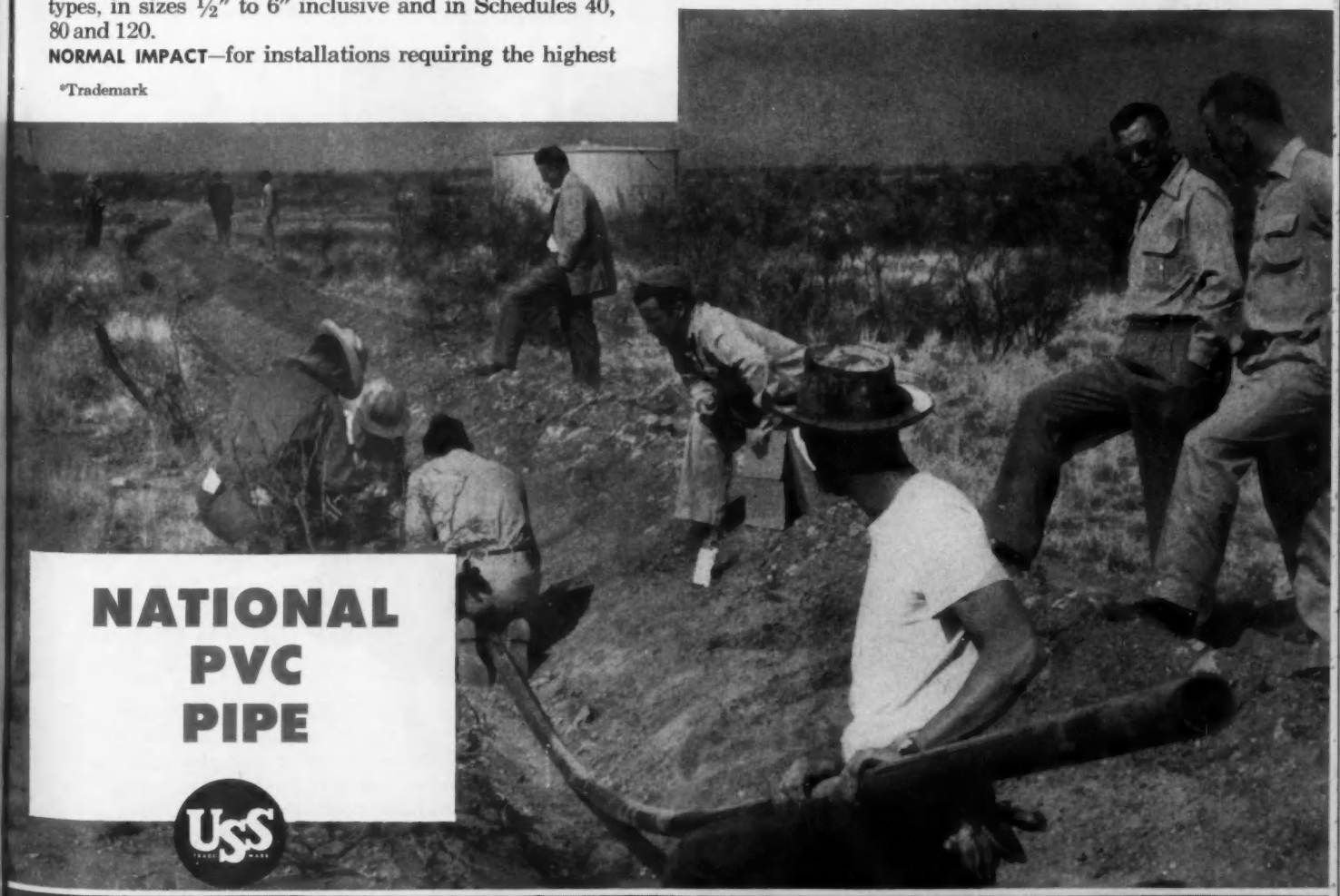
Rigid PVC Pipe is immune to acids, alkalis, salts, fungi, bacterial action and soils, as well as a multitude of chemicals. It may be joined by threading, heat welding, solvent cementing or adhesives. It is marked every two feet with size, schedule, pressure and temperature.

Send for Bulletin No. 24 and get the full story on USS NATIONAL PVC Pipe. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

This seal of the National Sanitation Foundation is carried on all USS National Polyvinyl Chloride Pipe, and means Tested ... Approved ... Sanitary!

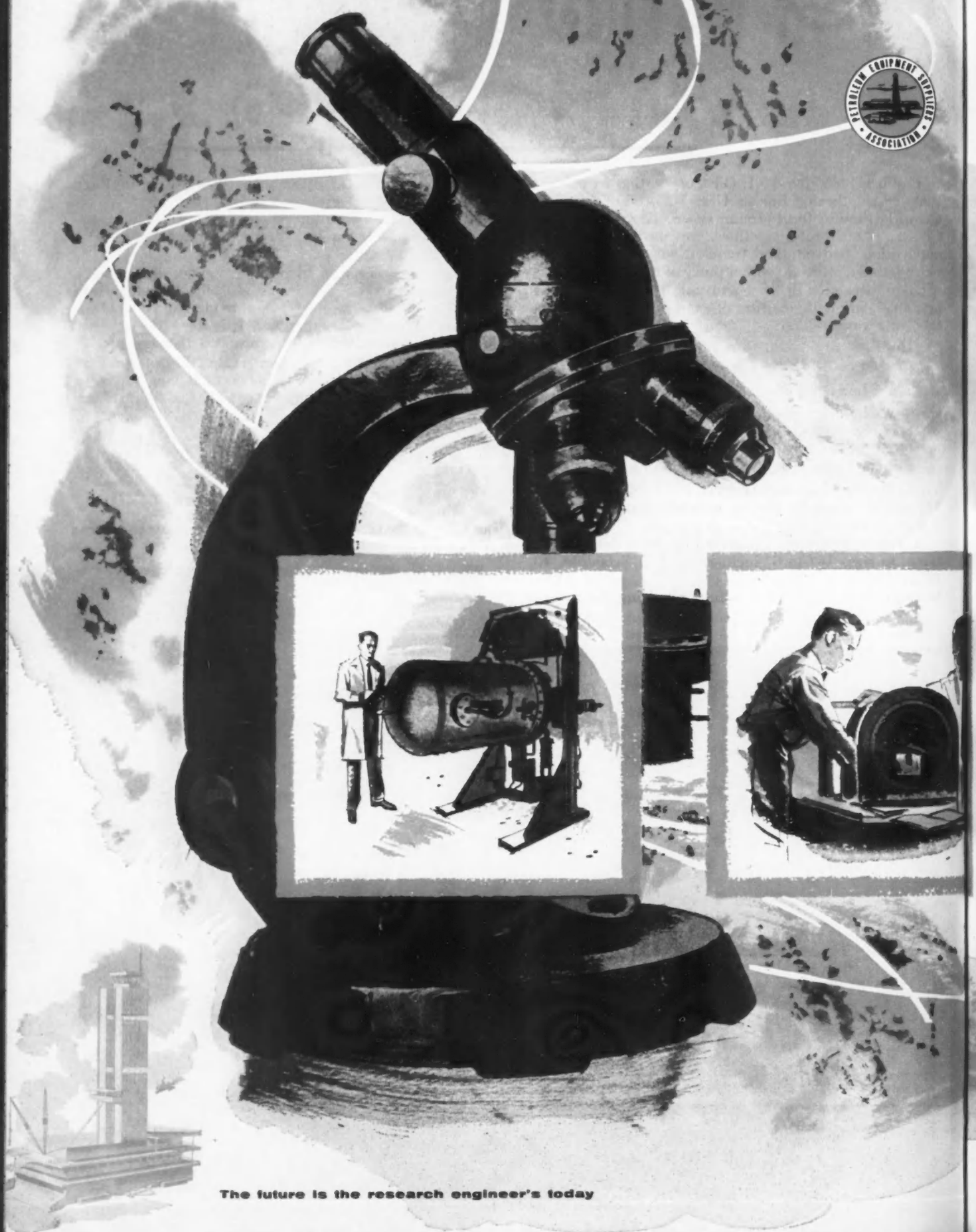
NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

*Trademark



UNITED STATES STEEL

To help you produce



PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

The future is the research engineer's today

oil cheaper P.E.S.A. members invest one hundred million dollars a year in **RESEARCH**

Jules Verne's "Eighty Days Around the World" was once regarded as a tale to stir the imagination of youngsters. But change outran Verne's imaginative story, making his predictions conservative indeed. Present day prophecies are even more breathtaking.

P.E.S.A. members are not startled at these fabulous prognostications, for their own scientists are predicting vaster things to come in the oil industry. They will not only keep up with the requirements of the industry but in many instances they will be ahead. We have only to look back twenty-five years to note the remarkable advances that have been made. Petroleum equipment manufacturers, supply companies, and service companies were in the vanguard of this progress.

The driving force of the free enterprise system is what has made these scientific conquests possible. The pioneering and inventive accomplishments of P.E.S.A. members year in and year out typify boldness and initiative in solving problems that would discourage lesser men.

The hundred million dollars a year that P.E.S.A. companies invest in research is assurance they will continue to develop new tools and methods and have them ready when and where needed.

Composed of: manufacturers whose plants make the finest precision equipment . . . *supply stores* who add two other ingredients of value—where you want it—when you want it . . . *service companies* who make available to their customers the practical results of the theoretical research of some of the most brilliant scientific and technical men in the world.

P.E.S.A.*

*Petroleum Equipment Suppliers Association

Diaphragm failures like this were eliminated by switching to neoprene

"Our emulsion treater valve diaphragms virtually never fail since we switched to neoprene," says Mr. A. I. Sellars, Chief Engineer, Maloney-Crawford Tank & Manufacturing Co., Tulsa.

Diaphragms in the valves of emulsion treaters take a beating chemically and physically. They are constantly exposed to oil, salt water and sulfur-laden gases at temperatures up to 170° F. And they must open and close continually as the well pumps. Once this meant trouble for Maloney-Crawford, makers of emulsion treaters.

"We tried several diaphragms of oil-resistant rubbers," reports Mr. Sellars. "They seemed to get hard and fail in a month or so. We did a brisk, and rather costly, replacement business much to our sorrow. Then we started using neoprene. In a year, our replacements fell off to nearly nothing."

Rugged neoprene—Du Pont's synthetic rubber—has a wide range of use in oil field equipment because it can take this kind of punishment. It resists sunlight, weathering and aging . . . oil and grease . . . abrasion and flex cracking—just about everything encountered in oil patches. So when you buy oil field rubber products be sure to specify the rubber with long, trouble-free service life: Du Pont neoprene.

This used to be common. Mr. Sellars shows how previous diaphragms, made of other synthetic rubbers, used to harden and fail—usually in about one month. Since neoprene diaphragms were substituted, "replacements have fallen off to nearly nothing."

NEOPRENE

MADE BY DU PONT FOR 25 YEARS

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . *through chemistry*

For more data on advertised products, use Readers' Service Cards, last page.

look for this — symbol

...it identifies all Dresser Companies and their products

	CLARK BROS. CO. compressors	DRESSER-IDECO COMPANY steel structures	DRESSER MANUFACTURING DIVISION couplings
THE GUIBERSON CORPORATION oil tools	IDECO drilling rigs	LANE-WELLS COMPANY technical oilfield services	MAGNET COVE BARIUM CORP. drilling mud
PACIFIC PUMPS, INC. pumps	ROOTS-CONNERSVILLE BLOWER DIVISION blowers	SECURITY ENGINEERING DIVISION drilling bits	SOUTHWESTERN INDUSTRIAL ELECTRONICS electronic instrumentation

...it is your guarantee of the DRESSER *plus+*

You gain an important extra plus value every time you are served by any of the Dresser companies. This is the unique way Dresser operates to serve you better. Each Dresser company works independently to assure maximum individual attention to your specific needs . . . yet all are teamed together in a single organization to provide a group of research, engineering, and manufacturing services. From Dresser you obtain equipment based on the over-all experience of many companies in many industries.

As performance demands on equipment become increasingly greater, Dresser will continue to pace the technological changes in your field. You can count on the Dresser companies as major suppliers of equipment researched and developed to serve you better and meet your future needs.

Wherever you are, whatever your needs, specify equipment from Dresser companies. No other single organization offers you the same broad range of "know-how" coupled with individual company attention to these specific needs. Be sure to look for the symbol that identifies the Dresser companies. It's your guarantee of the Dresser *Plus* + . . . the mark of superior equipment and services which have become the standard of comparison the world over.

DRESSER INDUSTRIES, INC.

EQUIPMENT AND TECHNICAL SERVICES

OIL • GAS
CHEMICAL
ELECTRONIC
INDUSTRIAL

REPUBLIC NATIONAL BANK BUILDING • POST OFFICE BOX 718 • DALLAS 21, TEXAS

Tomorrow's Progress Planned Today

For more data on advertised products, use Readers' Service Cards, last page.

HERE'S HOW Welex dyna-jet* SAVES ME MONEY

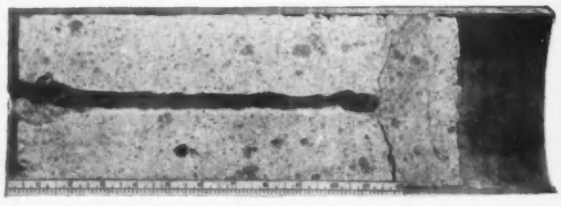
I

The Welex Dyna-Jet performance record since this new concept of perforating was introduced has proved itself a real money-saver to producers throughout the oil industry. Production data from every area shows an average

40% decrease in break-down pressures

This is more proof that the Welex Dyna-Jet is the greatest improvement in perforating since the introduction of the jet process by Welex more than 12 years ago.

II



Actual field performance has surpassed even laboratory experiments with the Welex Dyna-Jet. The actual meaning of *205% greater hole volume than present casing jets* takes an added importance when performance records show an average

40% increase in injection rates

The Welex Dyna Jet is a jet perforator with double-barrel power that insures greater production per unit of perforation and gives you extra dividends from your completion dollar.

An actual case history from a group of West Texas wells is a vivid example of Welex Dyna-Jet performance: A division geologist with a large independent stated that although his wells normally had been breaking down at 2400 p.s.i., recent wells perforated by Welex Dyna-Jet broke down at only 1200 p.s.i. At the same time, he reported that normal injection rates averaged between 18 and 20 bbls./min. Injection rates in his Welex Dyna-Jet perforated wells averaged 37 bbls./min.

**Trademark of Jet Research Center, Inc.*

Perforating is no sideline with WELEX!

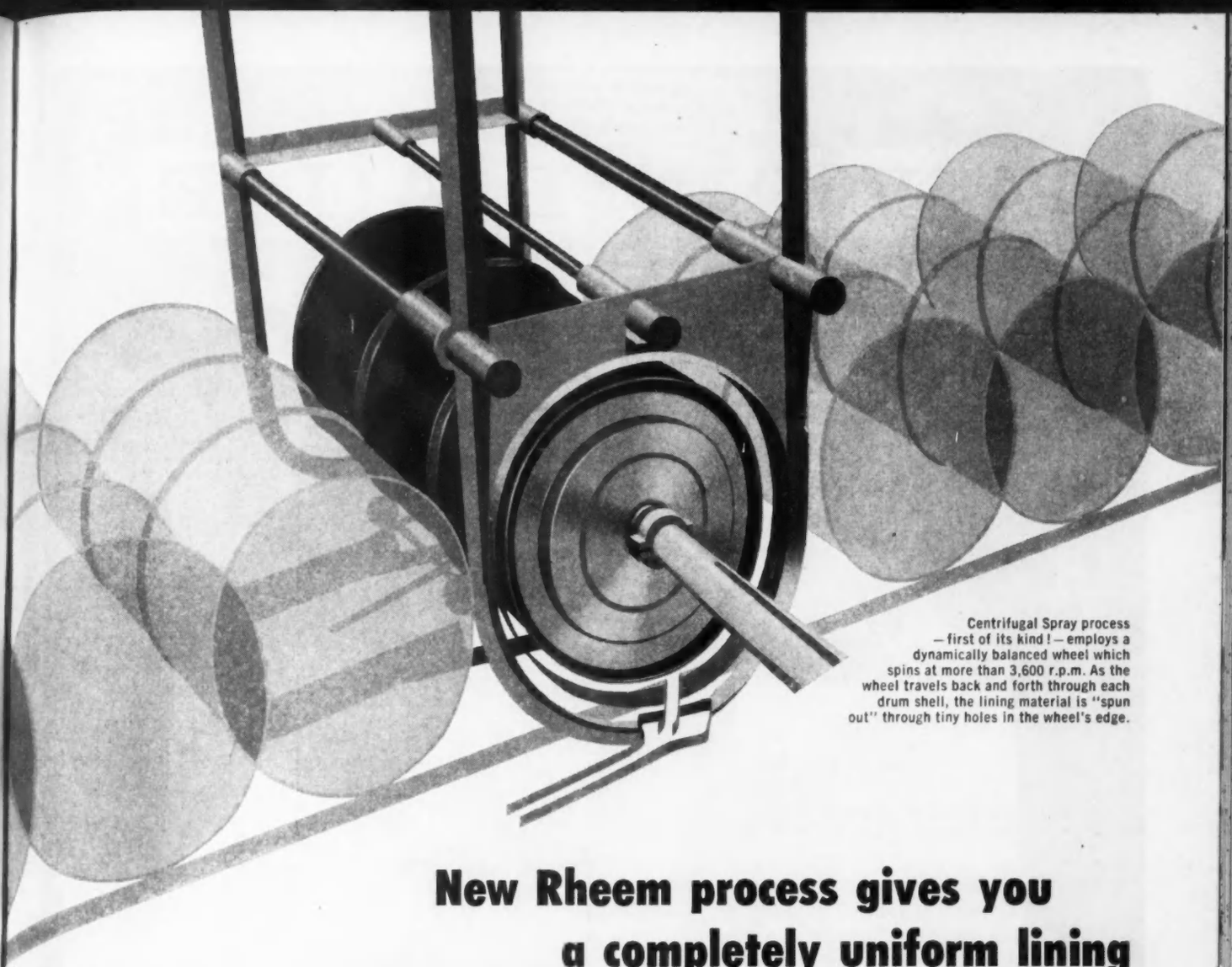
Originators of Welex Jet Perforating — Welex Jet Services, Inc.

WELEX JET SERVICES, INC.

1400 East Berry, Fort Worth, Texas

Division Offices: Denver — Houston — Midland — Oklahoma City — Tulsa. **Sales Offices:** Dallas — Wichita. **District Offices:** Abilene — Ardmore — Beaumont — Bowie — Corpus Christi Cortez — Falfurrias — Farmington — Great Bend — Hobbs — Houma — Houston — Kilgore — Kimball Lafayette — Lake Charles — Liberal — Odessa — Pampa — Pauls Valley — Pawhuska — Plainville San Angelo — Shawnee — Sherman — Shreveport — Snyder — Stillwater — Wichita Falls — Winfield

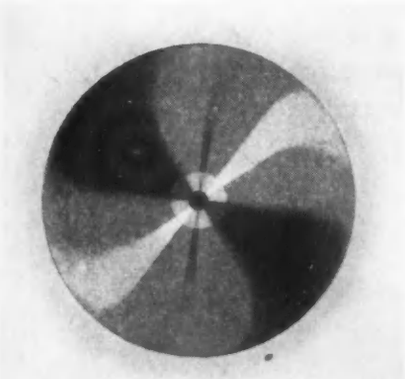
Welex *of Canada, Ltd.:* **Calgary — Drayton Valley — Edmonton — Red Deer**



Centrifugal Spray process — first of its kind! — employs a dynamically balanced wheel which spins at more than 3,600 r.p.m. As the wheel travels back and forth through each drum shell, the lining material is "spun out" through tiny holes in the wheel's edge.

New Rheem process gives you a completely uniform lining

...drum after drum after drum



New Centrifugal Sprayer spins off a continuous curtain of atomized lining material at a uniform rate.

Uniform lining thickness—controlled to within .1 of a mil
Uniform viscosity of lining materials with lower solvent content
Uniform application:

- Completely automatic · No air used in spray
- Spray travels same distance to coat all surfaces
- No air turbulence, primary air or drum rotation

Uniform curing:

- 3-stage ovens with controlled temperatures
- Controlled air flow by placing drums upright in oven

This new Rheem Centrifugal Spray process is so fully automatic, drum linings can't vary from one drum to the next, one day to the next.

It's a vast improvement over all other lining methods. For it does away with troublesome air turbulence that causes oil, dust and dirt to gum up linings applied by conventional methods.

It minimizes pinholing and blisters. It eliminates chance for human errors. It even helps the new Rheem high-temperature, vertical ovens do a still better curing job!

Why not contact our nearest office for full details.

YOU CAN RELY ON Rheem WORLD'S LARGEST MAKER OF STEEL SHIPPING CONTAINERS

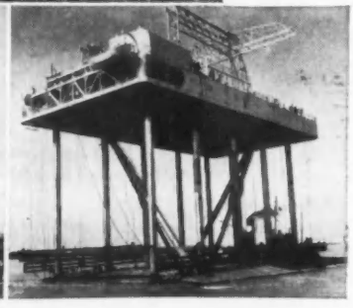
Rheem Manufacturing Company

4901 Jefferson Highway • New Orleans 20, Louisiana • 1025 Lockwood Drive • Houston 20, Texas

AVONDALE

Mobile Type Drilling Rigs

giants of the depths
probing riches unlimited



Avondale offers you outstanding facilities for engineering, research and construction of all types of offshore rigs . . . and we know our business. We have built and are now building some of the most famous rigs in the nation. We are prepared to work with your Naval Architect, or to handle all engineering and research ourselves through the facilities of our vast and capable Engineering Department. You will find our prices competitive —our delivery dates firm. Before you decide on a builder for your next rig—see Avondale.

SHIP BUILDING • SHIP REPAIRING • FOUNDERS • PROPELLERS • STRUCTURAL STEEL

AVONDALE MARINE WAYS, INC. CABLE ADDRESS "AVONWAYS"

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REHABILITATING INJURED WORKERS

Helping others to help themselves... Assisting the injured and handicapped to return to personal independence... Helping reduce the costs of workmen's compensation insurance... These are some of the gratifying results of one of the important services provided by the Texas Employers' Insurance Association — A rehabilitation program for workers handicapped as the result of industrial accidents.

Under the direction of our Medical Coordinator, several registered nurses, specially trained in rehabilitation work, are employed to coordinate the efforts of doctors, hospitals, therapists, the injured worker, his family and employer... in rehabilitating the injured worker and returning him to employment in the shortest time, with the least disability. Last year thirty-two such cases were handled with excellent results.

This is just one of the extra services rendered by Texas Employers' Insurance Association, Texas' largest writer of workmen's compensation insurance. Why not take advantage of your opportunity to obtain such services?

For full information, call or write our nearest service office listed below, or write direct to:

TEXAS EMPLOYERS' INSURANCE ASSN. DALLAS, TEXAS

Symbol of leadership in
WORKMEN'S COMPENSATION
Insurance

•

Outstanding opportunities in Sales, Claims, Engineering and other departments for qualified young men.

TEXAS EMPLOYERS *Insurance Association*

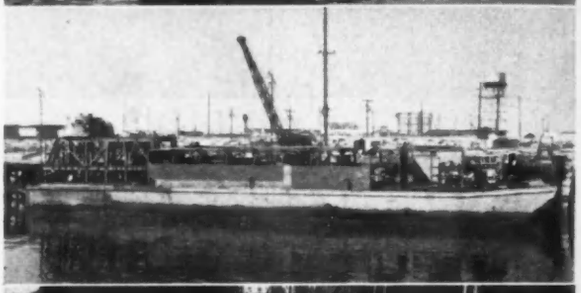
A. F. ALLEN, Chairman of the Board
BEN H. MITCHELL, President

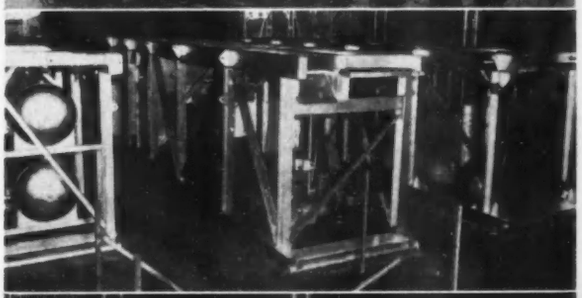
HOME OFFICE Employers Insurance Building DALLAS, TEXAS

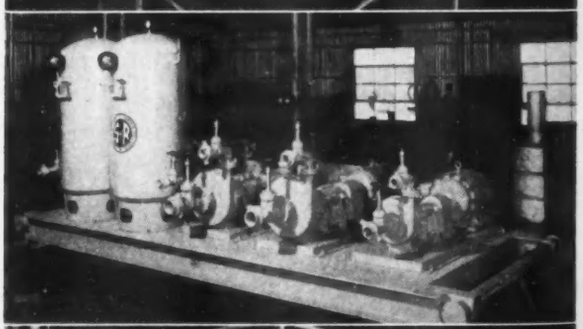
Service Offices: ABILENE • AMARILLO • AUSTIN • BEAUMONT • CORPUS CHRISTI • DALLAS • DALLAS (Oak Cliff) • EL PASO • FORT WORTH • FREEPORT • GALVESTON HARLINGEN • HOUSTON • LUBBOCK • MIDLAND • ODESSA • PORT ARTHUR • SAN ANGELO • SAN ANTONIO • SHERMAN • TYLER • WACO • WICHITA FALLS

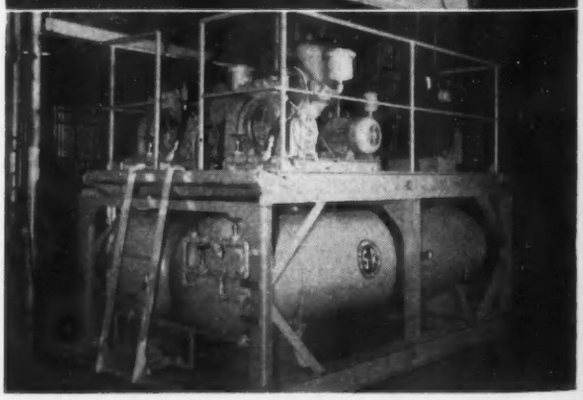
For more data on advertised products, use Readers' Service Cards, last page.

FOR EXPERIENCED, DEPENDABLE FABRICATING, UNITIZING AND MACHINING SERVICE









S & R's experience includes fabricating and unitizing for offshore operations, where built-in dependability in minimum space requirements must be met. Being a distributor for all major manufacturers of power transmission equipment, pumps, generators, engines, compressors, etc. — all component parts can be unitized quickly and economically.

S & R's 55,000 sq. ft. plant operated by experienced oil country men — from the front office to the loading area — assures you competent, fast and economical work . . . whatever the job. Call or write for details on how S & R can help you.

You don't get double-talk — you get satisfaction when you choose S & R for oil country work.

SPECIALISTS IN

Assembly and Rig-up for Export
Unitizing **Fabricating**
Repairing **Machining**

S & R TOOL & SUPPLY CO.

P. O. Box 1755

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GUIBERSON SWABS DO A

GOOD LOW COST JOB!

GUIBERSON'S Type J

Type L

Type GW

Here are three swabs capable of swabbing all sizes of tubing and drill pipe — in a minimum of time — making them most economical and efficient for routine swabbing. Many other types of Guiberson cups are immediately available for *specific* and *unusual* swabbing problems.

SAFE THAN SORRY — BETTER BE — GUIBERSON

THE GUIBERSON CORPORATION

ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

ONE OF THE DRESSER INDUSTRIES

Sold by Oil Field Supply Stores Everywhere

For more data on advertised products, use Readers' Service Cards, last page.

Why this pile of sand means lower drilling costs for a South Louisiana operator

The sand in this picture is part of nearly 1500 barrels that a Dorrco D-Sander removed from the mud in drilling one well in South Louisiana. Notice the sharpness of the cliff-like edges which show that the D-Sander not only removes coarse sand but also a great deal of silt and drilled clay solids.

As a result of this, pump parts last longer, bits drill faster and last longer, drilling time is reduced and the cost of mud chemicals is lower.

In one series of controlled comparisons a Dorrco D-Sander saved an average of more than 5,000 dollars per well. Because of savings like this, more and more contractors are installing Dorrco D-Sanders as standard equipment on all their rigs.

Write for Full Information.

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SALT WATER CONTROL Inc.

A Sid Richardson Development Company

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There are always new stars in the SIE firmament

From the first SIE seismic instruments, the GA-7 through the GA-7H . . . to the first concepts in truly portable instrumentation which culminated in the P-11 Series . . . on to the G Series systems for magnetic and photographic recording . . . then the DRF Flow Control Systems and the MR group of field and portable magnetic recorders . . . continuous research and improvement have added new stars to the SIE firmament.

With the constant increase in SIE research and development activities for instrumentation and automation, you can expect added lustre in this galaxy every year.

Industrial Instrumentation for Industrial Progress

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SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY

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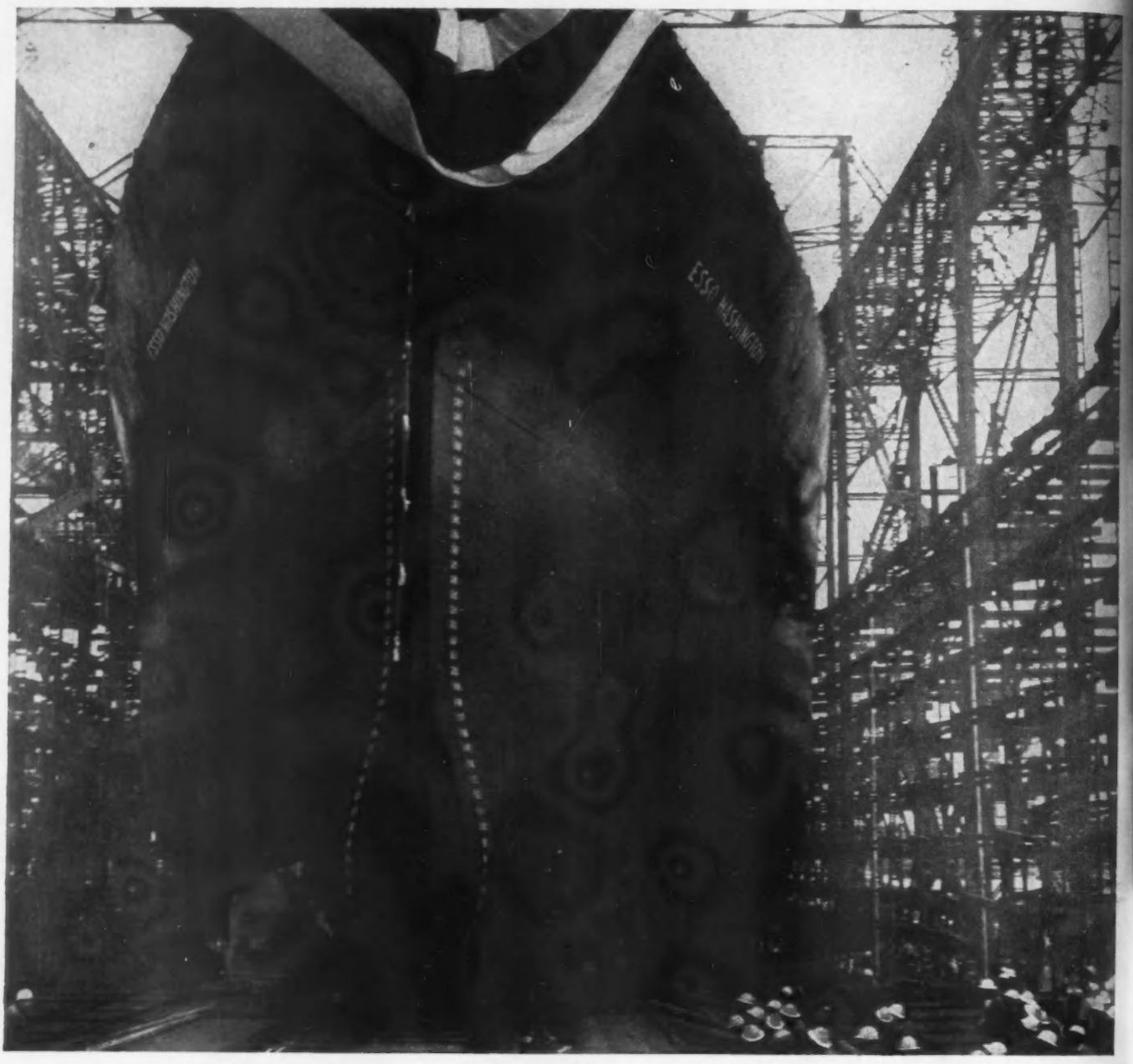


13 MILLION GALLONS BIG...BUT JUST A DROP IN THE BUCKET

The ESSO WASHINGTON is the newest of the 110 ocean-going tankers in the Esso fleets. She can carry 13 million gallons of oil. But that's just a drop in the bucket compared with the 40 billion gallons that Jersey Standard affiliates delivered to customers last year.

As economies expand . . . as populations grow . . . as people live better, oil must provide more energy to power factories, to drive ships and planes and motor vehicles, to heat and light homes and offices. Last year we supplied more than twice the oil we did ten years ago. This year our customers will need still more.

It's a big job . . . and it requires vast amounts of costly equipment. As our Annual Report points out, we spent $1,083,000,000 last year searching for oil and gas and paying for such things as tankers, pipelines and refineries. And in 1957, we plan to spend another $1,250,000,000 to find, produce and deliver the oil people will be needing tomorrow...and ten and twenty years from now.

Because Jersey Standard is willing and able to make such investments and because our operations are efficient, we make a profit. In 1956 it was $808,535,000. About half of it went back into the business to help pay for the new facilities.

Our successful year was good news for the 403,000 shareholders who own the company . . . they got dividends of $2.10 per share on the money they invested.

It was good news for our 156,000 employees . . . whose wages and benefits came to $906,000,000.

It was good news for governments. Operating and income taxes, import duties, consumer taxes and other payments from our operations brought to the United States and other governments a record $2,171,000,000. That was five times the dividends to shareholders, more than double the payroll and benefits to employees.

Best of all, our operations were good news for the people of the free world, who rely heavily on the energy of oil for their economic and social progress.

In this, our 75th anniversary year, we intend to continue our efforts to remain successful, profitable and growing, in order to serve people well.

If you would like a copy of our 1956 Annual Report, write us at Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

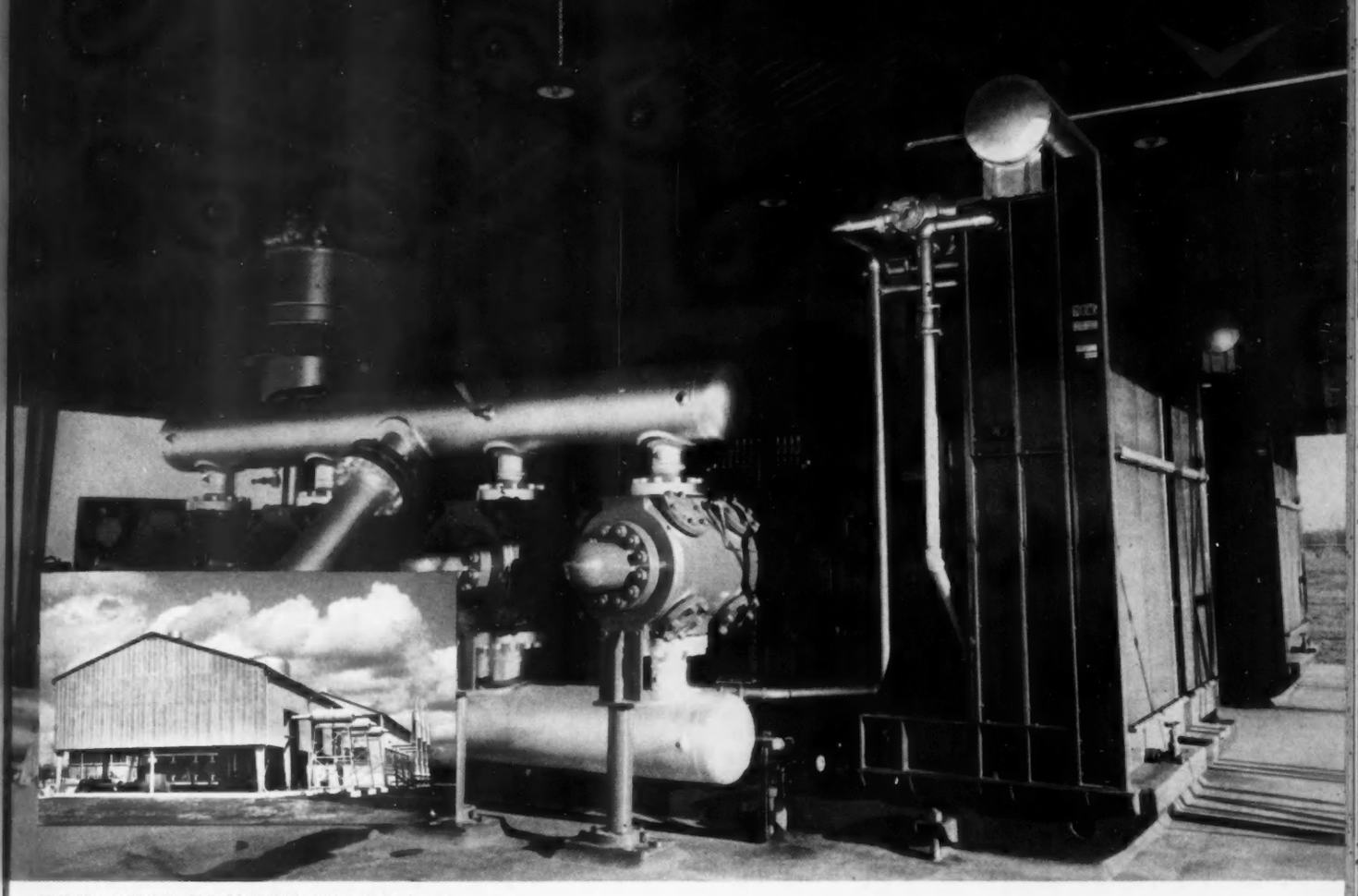
Esso 75 YEARS

STANDARD OIL COMPANY (NEW JERSEY)
AND AFFILIATED COMPANIES

producing energy for an abundant life

For more data on advertised products, use Readers' Service Cards, last page.

BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



SOUTHERN NATURAL GAS COMPANY's White Castle Supply Line Station, equipped with two Beaird-Ingersoll-Rand 10-SVG, 550 h.p. packaged compressors. Shown in inset is the Toca station where three 12SVG, 660 h.p. Beaird packaged compressors have been installed to supplement three large stationary units. Other sizes available from 120 to 660 h.p.

Economical Expansion —

PACKAGED UNITS ADDED TO STATIONARY COMPRESSOR INSTALLATION

SOUTHERN NATURAL GAS COMPANY's growing supply line systems are reaching toward the Gulf on both east and west sides of New Orleans. Pacing this expansion are two new packaged compressor installations boosting the increased gas volume to the main supply line station at Gwinville, Mississippi. The east side line is handled by the enlarged compressor station at Toca, Louisiana. Formerly equipped with three large stationary compressors, this plant has been expanded by adding three 12SVG 660 h.p. Beaird-Ingersoll-Rand packaged units. On the west line a new station at White Castle equipped with two 10SVG 550 h.p. units is offsetting the increased line pressure from Toca station and handling added gas volume.

Southern Natural selected packaged compressors for their expansion program as a result of their field experience. Package units have proved more flexible in service, were more economical to install, required less foundation work and when no longer needed can be almost wholly salvaged. Packaged compressor equipped stations have also been found to be easier and more economical to design for future horsepower additions.

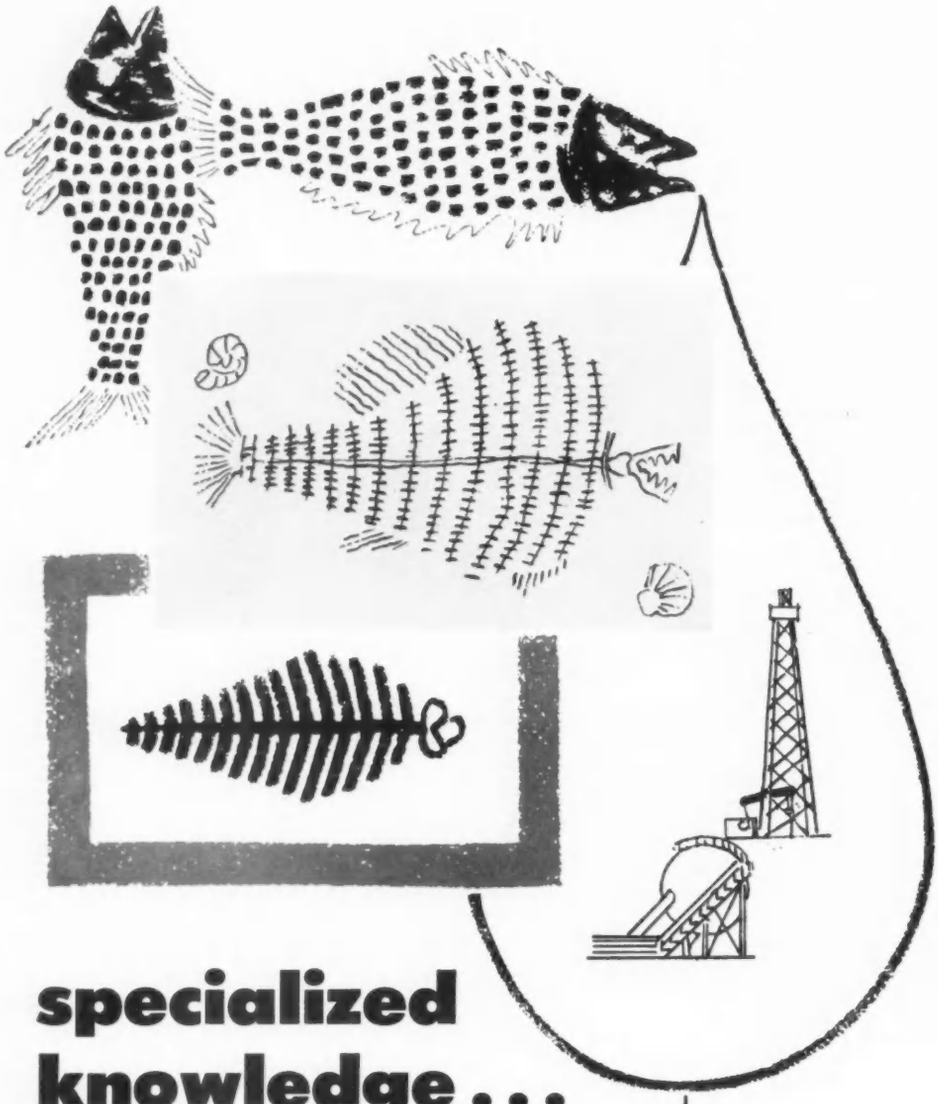
Let us show you how economically Beaird-Ingersoll-Rand packaged compressor plants can be added to your compressor station.

BEAIRD
another AMF product
PACKAGED COMPRESSOR PLANTS

LOWEST COST PER HORSEPOWER INSTALLED

THE J. B. BEAIRD COMPANY, INC.
Shreveport, Louisiana
A subsidiary of American Machine & Foundry Company

SHREVEPORT, LOUISIANA • *Sales Offices: Dallas, Houston, Corpus Christi and Midland, Texas • New Orleans, Louisiana • Tulsa, Oklahoma • Denver, Colorado Los Angeles, California • Caracas, Venezuela, and Cie. Ingersoll-Rand, Paris, France.*



specialized knowledge . . .

of the oil industry
is important to sound
financing of oil operations.
That's why you hear more and
more oil men say:

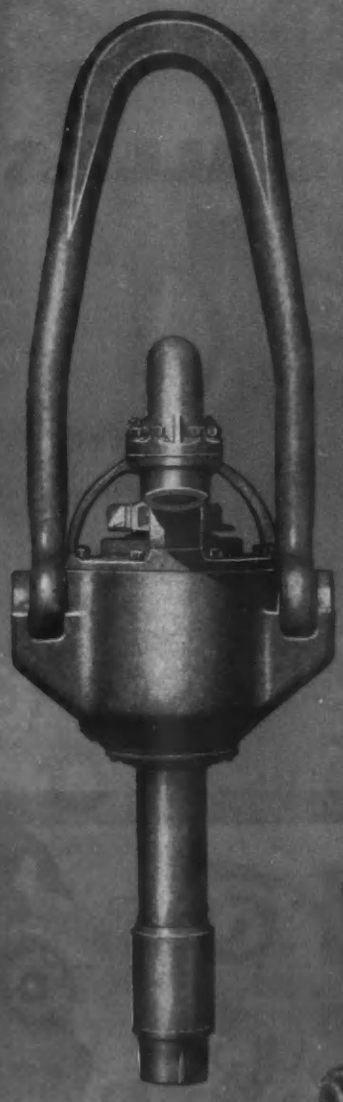
"for my money . . . it's THE FORT WORTH NATIONAL BANK"

FWNB

CAPITAL AND
RESERVE ACCOUNTS
OVER $20 MILLION

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

HELPING BUILD A GREATER
FORT WORTH AND SOUTHWEST

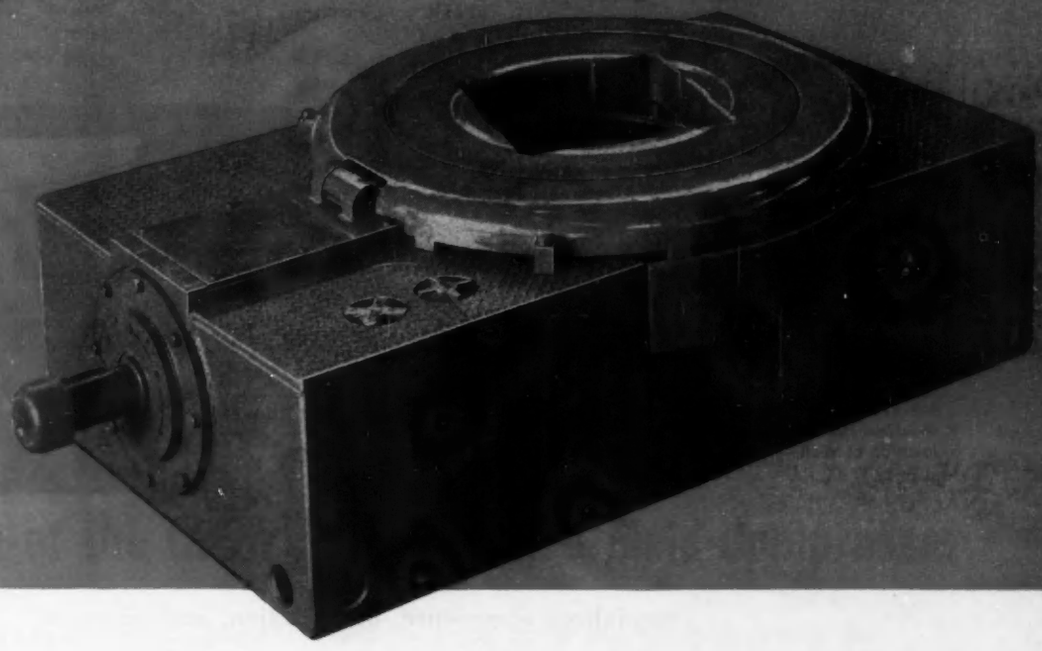


CONTINENTAL-EMSCO

ROTARY TABLES AND SWIVELS

A SUPERIOR COMBINATION FOR ROTARY DRILLING

Modern drilling requires the best... Continental-Emsco field proven Rotary Tables and Swivels meet every requirement.



CONTINENTAL-EMSCO "L" SERIES SWIVELS

Higher capacity swivels with their reduced weight and bulk give you outstanding features like cartridge packing, Timken main bearings, straight roller and Timken alignment bearings, improved forged steel bail installed with bail pins in double shear, replaceable bail pins and hardened races for oil seals. Engineered and built for better performance, lower maintenance costs and greater safety for owners.

CONTINENTAL-EMSCO "P" SERIES ROTARY TABLES

Through the construction features of oil bath lubrication, direct table lock, spiral bevel gears, high capacity main bearing system, box-type fabriform frame and highly effective exclusion of mud, these rotary machines meet the rigid requirements of drilling everywhere. Safety is emphasized by the raised table guard and the complete enclosure of moving parts.

Call your nearest CONTINENTAL-EMSCO representative for complete information on this preferred equipment

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

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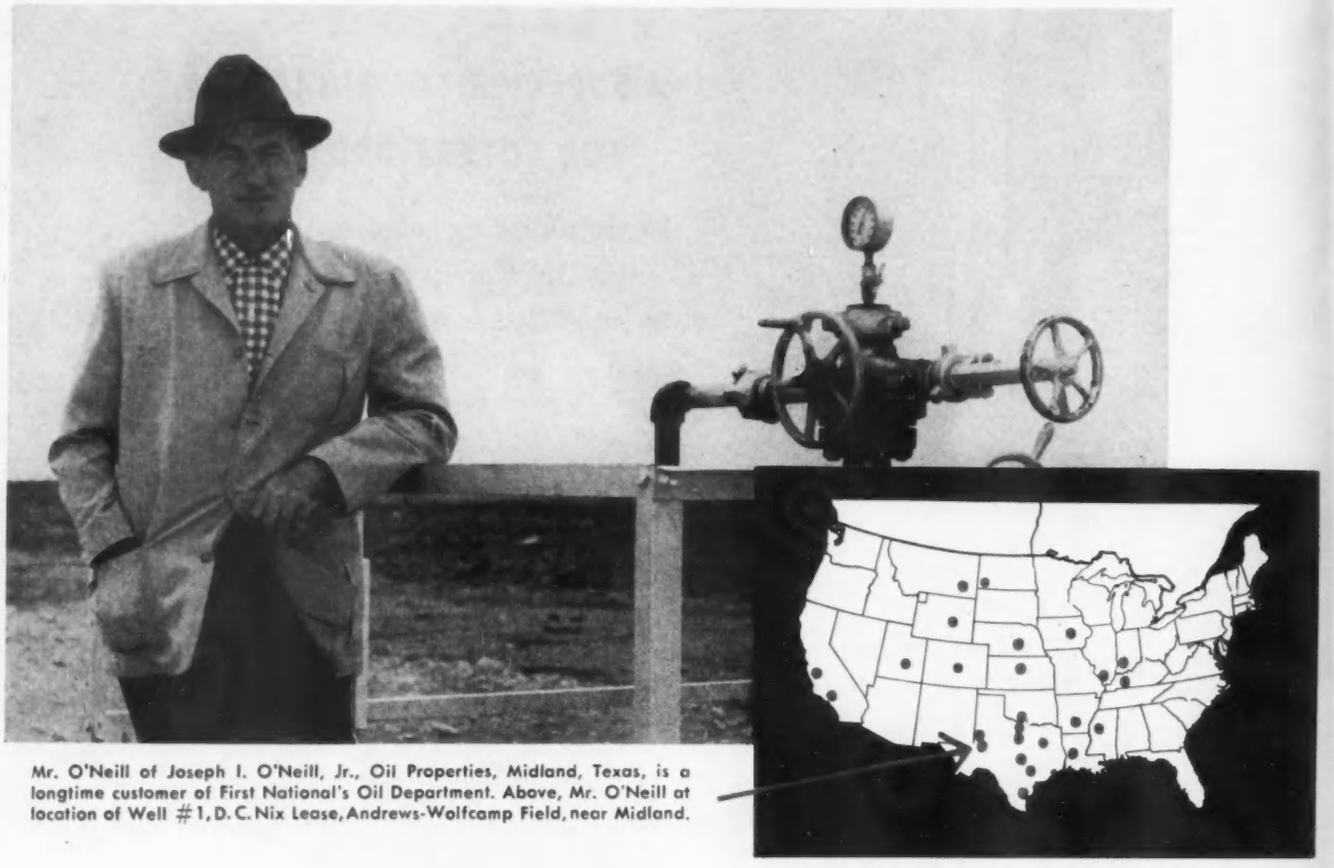
Representatives in All Principal Oil Fields of the World

R-706

Oil Financing from the **FIRST** *in* **DALLAS** *goes where you go...*



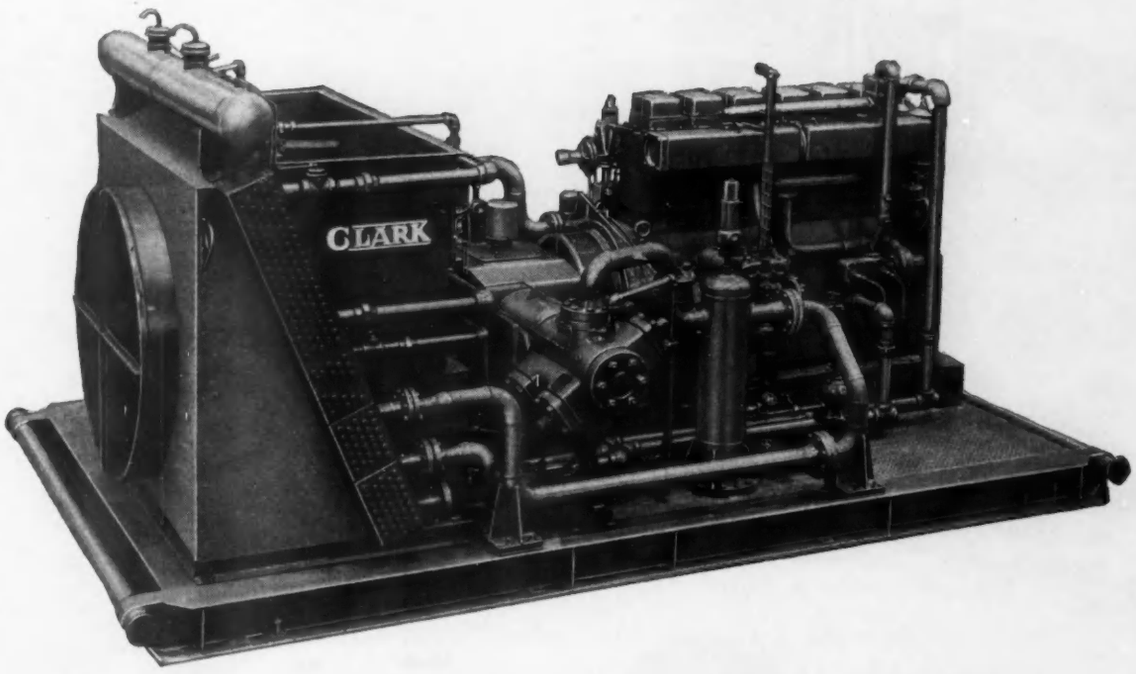
Mr. O'Neill of Joseph I. O'Neill, Jr., Oil Properties, Midland, Texas, is a longtime customer of First National's Oil Department. Above, Mr. O'Neill at location of Well #1, D. C. Nix Lease, Andrews-Wolfcamp Field, near Midland.

Specialized experience, organization, and resources to help you with practically any kind of need for "working money".

FIRST NATIONAL BANK IN DALLAS

Member Federal Deposit Insurance Corporation

put FIRST financing in your own oil future



DIRECT DRIVE...

A unique feature of the Clark CFA Packaged Field Compressor

One of the simplest ways to take the bugs out of packaged field compressors is to direct-couple the compressor to the engine. Clark engineers did exactly that when they designed the new CFA. Troublesome, power-robbing belts and gears between the engine and the compressor are not required. A simple rubber block coupling takes their place. But this achievement was made possible only because the CFA is so perfectly balanced and therefore can operate at a modern 1,000 rpm. without a quiver or a shake. Furthermore, the CFA is typically Clark. It has the built-in stamina and precision of its big brothers. You'll deplete the field, but you won't wear out the Clark compressor.

There are two and four cylinder CFA models available in the 100-350 bhp. range. Your nearest Clark representative has all the facts and can tell you of other operators' experiences with the CFA.

CLARK BROS. CO. **OLEAN, N. Y.**

One of the Dresser Industries

Offices in Principal Cities Throughout the World

CLARK **Packaged Field Compressors**

For more data on advertised products, use Readers' Service Cards, last page.

Here Basinger's HD-6 backfills a slush pit. Operator Tevebaugh says, "I can't say enough about this machine. It's tops."

"Best tractor I've ever used—a 'lifesaver' in emergencies"

. . . *says Oklahoma contractor*

"In fourteen years of oil field dirt moving, I haven't used anything that matches my new Allis-Chalmers HD-6 tractor-dozer. It moves more dirt, clears timber and builds roads faster, and it's a real 'lifesaver' in emergencies," says A. E. Basinger, Bartlesville, Oklahoma, oil field contractor.

"If a well busts out we've got to dig a new slush pit to catch all the oil or salt right away—no matter what the time or weather. That's when this HD-6's big output really pays off. Another thing, with that direct electric starter, it's ready to go in seconds."

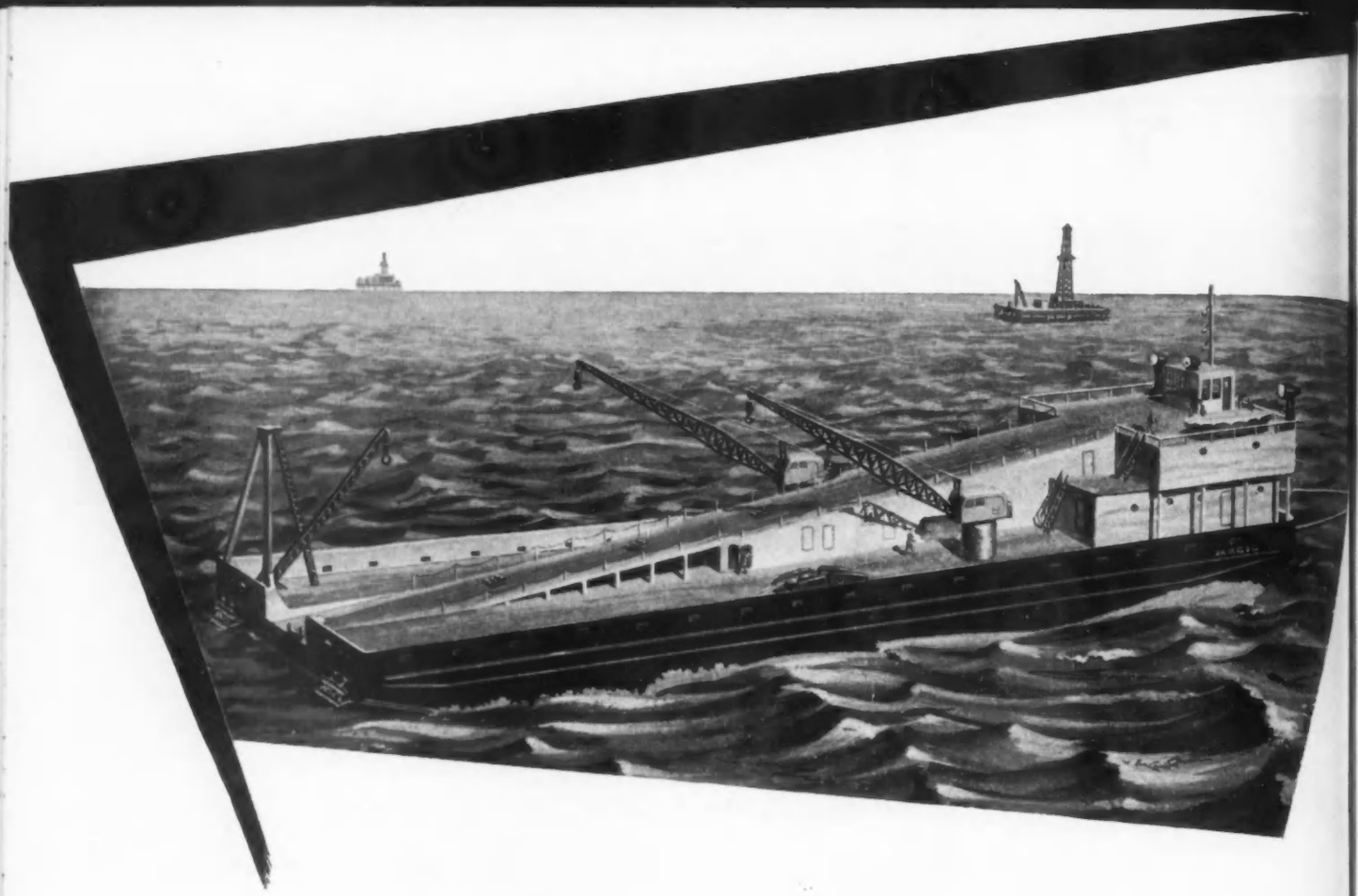
Says veteran operator L. B. Tevebaugh, "This tractor's the best I've ever operated. It starts fast, handles easy, won't kick back in the rough spots. Seat's comfortable, brakes are good. It's so well balanced I can operate in places I couldn't work a tractor before. On hillside diggin' for a rig site, the tilt blade helps me level up in half the time.

"Another thing with the Allis-Chalmers setup, I don't waste a lot of time greasing idlers and sprockets. I sure wouldn't want to go back to the old way."

Basinger's HD-6 digs and fills about 100 slush pits a year. It also builds roads and creek crossings, digs ditches, levels well sites, clears timber, moves heavy machines and tanks.

Find out how Allis-Chalmers crawlers can pay off on your leases. Your nearby dealer can give you the facts. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS *Engineering in Action*



Offshore Equipment
from Marine Fabricating & Engineering is the

basis for the best

When the concept of the revolutionary offshore pipelaying vessel "Magic" began to take shape, Marine Fabricating & Engineering facilities were made an integral part of this remarkable accomplishment from keel laying to commissioning. The Marine Gathering Company offshore operations specialists, like so many of the industry's leaders, found MFE construction techniques could save valuable time and money . . . and most important . . . insure that the high standards for "Magic's" construction were met.

When planning any phase of a vessel design and construction program . . . consult MFE . . . you'll be certain that your equipment has the **best basis** available from every viewpoint.

MARINE FABRICATING & ENGINEERING CO.

P. O. Box 9746
Houston 15, Texas

Add your own success story to these

Results of fracturing using Adomite and lease crude

		Gallons Fracturing Fluid	Pounds Sand	Injection Rate BPM	Production, BOPD Before	After	30-60 Days After	6 Months After
	tion	10,000	10,000	5	2	28	35	—
		15,000	21,000	5	4	54	120	65
		6,000	12,000	3	8	49	51	51
		6,000	6,000	4	*	345**	144	80
		6,000	12,000	10	Dead	455	306	192
		6,000	10,000	5	10	—	33	30
		000	12,000	10	*	—	330**	360***
			20,000	6	6	—	90	51
			5,000	5	4	55	45	52
H.			3,000	12	50	230	180	99
I.	Sussex		000	9	20	70	.07	51
J.	Shannon B			6	0	90	80	.68
K.	Shannon B	5,000	4,...	12	16	106	49	30
L.	Deese	4,000						
M.	Huntley Cgl.							

*New completion zone **Flowing ***Pumping

fracture with Adomite

Adomite®—and only Adomite does so many things so effectively

Seals the fracture face . . . minimizes fluid loss . . . no damage to formation.

Longer fractures . . . deeper penetration of sands.

Fewer sandouts . . . reduces fluid loss in rock matrix, prevents buildup of sand concentrations in the fractures.

Saves you money . . . utilizes your own lease crudes . . . saves transportation costs.

Decreases friction loss . . . low viscosity of Adomite-created fracturing fluids permits use of less pumping equipment than with viscous refinery residuals.

Reduces hazard of emulsions . . . emulsion-breaking characteristics are important consideration to many producers.

Adaptable to virtually all types of crude, Adomite is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.

Producers who say Adomite . . . stay with Adomite.

Get greater profits from your next fracturing job—

TELL YOUR SERVICE COMPANY TO USE Adomite

© 1957, Continental Oil Co.

For more data on advertised products, use Readers' Service Cards, last page.

The "Cone Nebula" in the constellation of Monocerus photographed through the 200-inch Hale telescope of the Palomar Observatory. This mass of stars is about 1,000 light-years, or roughly six million billion miles from the earth.

MEASURING THE UNSEEN

Although attempting nothing so spectacular as measuring unseen stars through a 200-inch telescope, Tuboscope research is paying off for oil men everywhere. From Tuboscope research have come new instruments for measuring the nearly unseen effects of wear, fatigue, and corrosion in oilfield tubular goods. And from Tuboscope experience in the field comes the ability to inspect and to grade your tubular goods with the greatest possible precision and with the least chance for human error. The important factors of bottom hole pressure and temperature are measured by Tuboscope's Subsurface Engineering Division.

2919 HOLMES RD. • HOUSTON, TEXAS

Tuboscope COMPANY

Where You Need a "HE-MAN" Pump

Ready for shipment, this Emsco DA-850 with Mid-Continent Swinging pump drive is scheduled for service in Venezuela.

EMSCO
DA-850

INSTALLATION ENGINEERED

by MID-CONTINENT

You get *more* with an Emsco DA-850 from Mid-Continent. Expert installation engineering is available to help you get top pump performance. Mid-Continent's field parts stocks simplify your field operations. Mid-Continent's around-the-world equipment supply is always near, wherever your location — the muskeg of Canada, offshore Louisiana, or Venezuela. Call your Mid-Continent man for complete mud pump information.

FIELD-PROVEN FLUID END DESIGN INCREASES EFFICIENCY; SIMPLIFIES MAINTENANCE

THREADED VALVE POT COVERS field proven over eight years permit quick and easy access to valves.

EXPOSED LINER CONSTRUCTION field proven over fifteen years. Lessens possibility of fluid end washouts.

STEEL FLUID END is composed of steel castings electrically welded into integral units for maximum strength and minimum weight.

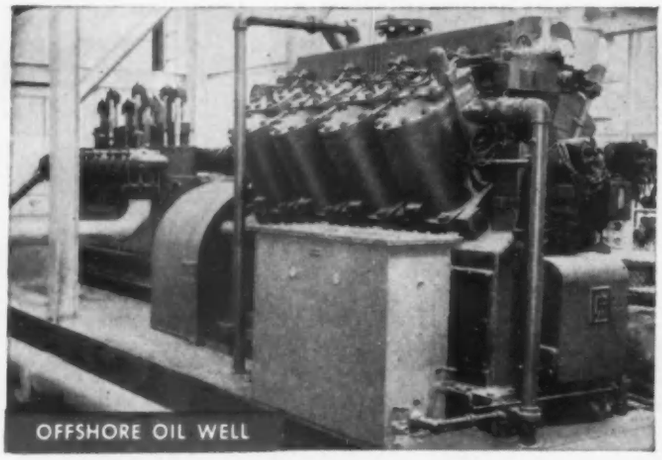
EXCLUSIVE EXPORT DISTRIBUTOR
Export Division: 45 Rockefeller Plaza, New York 20, N. Y., Cable: MIDCUMPORT NYK

PESA — PARTNERS IN PETROLEUM PROGRESS

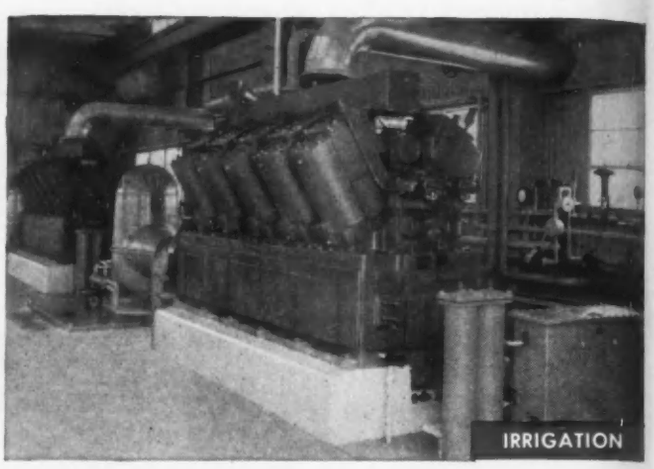
MID-CONTINENT Supply Company

MID-CONTINENT BLDG. FORT WORTH, TEXAS

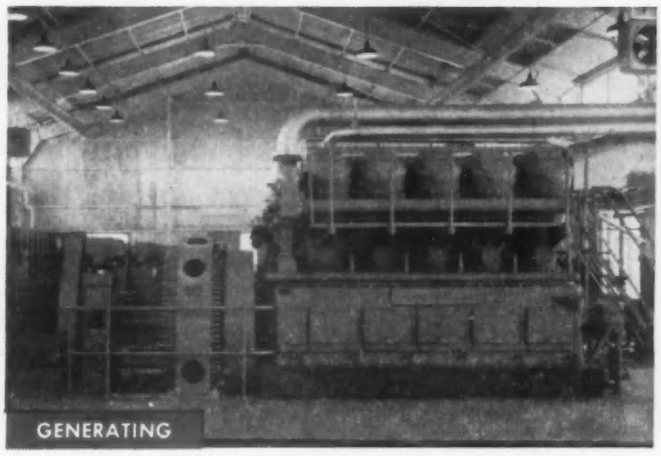
THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY



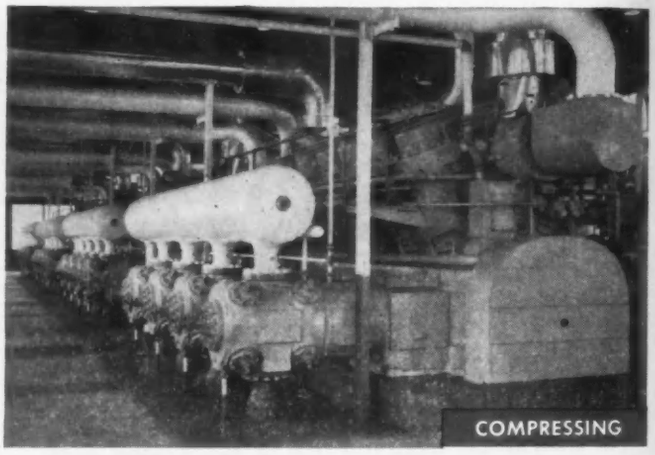
This 295-hp PJVG gas engine is mounted on a platform in the Gulf of Mexico driving a reciprocating crude oil pump. PJVG engines are built in 220 and 295-hp sizes.



The 680-hp PSVG units above are driving Ingersoll-Rand centrifugal pumps on a large irrigation project. PSVG gas engines cover the 408-816-hp range.



This 1100-hp PKVG is shown at the task most frequently assigned to I-R power units: a-c generator drive is a natural for smooth-running I-R 4-cycle gas engines. PKVG's are available from 880 to 1760 hp.



All I-R gas engines are also offered in integrally-built engine-compressor units. Above are 2000-hp turbo-charged KVS compressors on gas transmission. 4-cycle engine-compressors are available from 120-2000 hp.

POWER for any purpose

gas engines deliver heavy-duty power economically

Whatever the task, Ingersoll-Rand heavy-duty 4-cycle gas-engine equipment offers the highest dependability, flexibility and long-run economy. Built for 24-hour-a-day, continuous operation on a wide range of fuels, these engines are especially suitable where close control is important (such as a-c generator drive). Where I-R power units and their companion engine-compressors are used together, the similarity of operation and the interchangeability of parts effects additional important economies. Contact your I-R representative now for more information.

4-CYCLE

Ingersoll-Rand

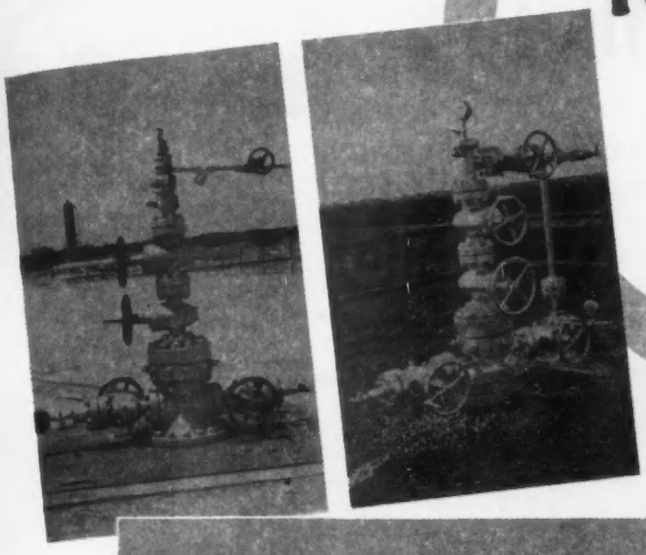
6-491

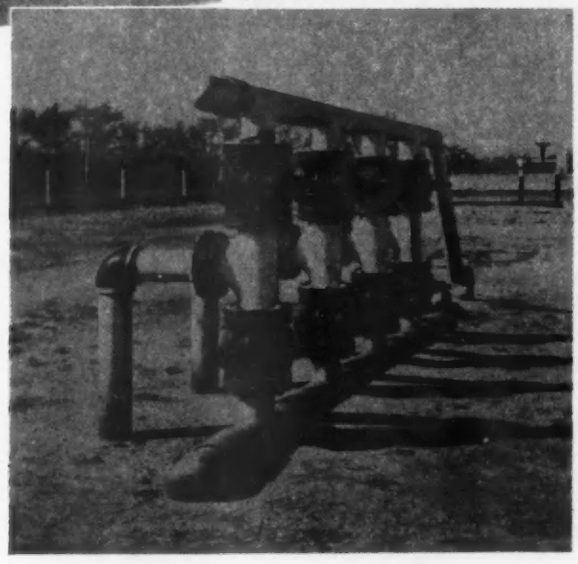
11 Broadway, New York 4, N.Y.

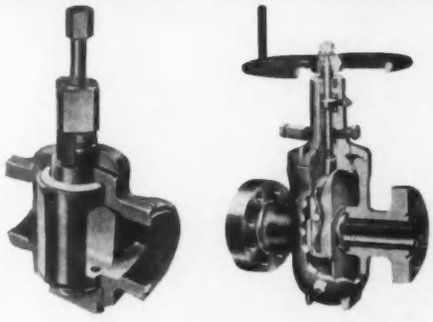
COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS

FROM W-K-M

high PRESSURE and low PRESSURE valves







Here's wide range availability for both high and low pressure services from **W-K-M**.

For safe and positive high pressure control on christmas trees, flow wings, and flow lines, it's **W-K-M** Through-Conduit Gate Valves to handle working pressures from 500 to 15,000 psi.

For "expressway" turbulence-free flow in oil and gas pipelines, it's **W-K-M** ASA Through-Conduit Gate Valves from ASA 300 lbs. to ASA 1500 lbs.

For gathering lines, manifolds, headers and similar low pressure services, it's **acf** Lubricated Plug Valves—200 to 500 lbs. WOG.

You need dependability, performance, minimum maintenance! You need **W-K-M** and **acf** Valves, designed specifically to meet your requirements, in oilfield services, on pipelines, in refineries, in process and chemical plants, and wherever valves are required to control the flow of liquids or gases.

Complete your file of valve information by writing for these W-K-M Catalogs. Address Dept. D-6.

W-K-M Catalog 200	W-K-M Through-Conduit Gate Valves for oil field services
W-K-M Catalog 300	W-K-M ASA Through-Conduit Gate Valves
W-K-M Catalog 400	ACF Lubricated Plug Valves
W-K-M Catalog 800	ACF Lubricant Manual

WEST TEXAS—NEW MEXICO STOCKS

Hobbs.....321 So. Grimes St.—Phone EXpress 3-5004
Odessa.....207 No. Amburgey—Phone FEderal 6-9611

W-K-M

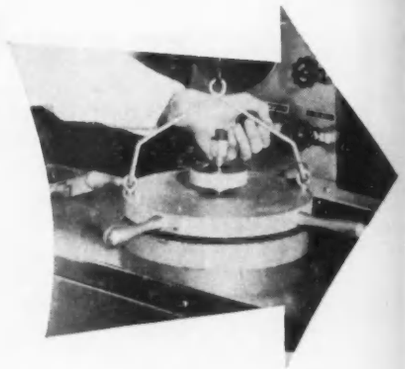
DIVISION OF **acf** INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS
MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

5709

MANUFACTURERS OF W-K-M GATE VALVES · acf LUBRICATED PLUG VALVES · KEY-KAST ALLOY STEEL PIPING FITTINGS · KEY RETURN BENDS AND FITTINGS

CEMENT CHEMISTRY



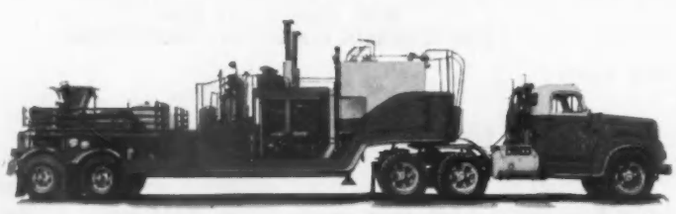
Among the dozens of cements and additives in the Halliburton cementer's roster of materials for special applications are these . . .

CEMENTS

PRODUCT	COMPONENTS	PROPERTIES	APPLICATIONS
POZMIX 140	Pozzolans and lime. Set control additives to meet varied well conditions.	Excellent pumpability and strength stability at high temperatures. Very economical. Very low friction coefficient. Excellent perforating characteristics.	Primary and remedial cementing of deep wells with temperatures from 140° to 400° plus. Selected weighting agents allow slurry weight control from 14 to 19 lbs. per gallon.
RESIN CEMENT	Portland cement and thermosetting resins plus set control additives.	Resin filtrate penetrates permeable formations. Set product is highly resistant to corrosive fluids.	For tail-in casing, plug back or squeeze cementing jobs.
CAL-SEAL	Special high strength gypsum cement.	Expands on setting. Quick set. High early compressive strength.	Plug back, lost circulation, casing leak repairs, bridge plugs, shot tamps.
CAL-SEAL—PORTLAND CEMENT	Cal-Seal, portland cement.	Extremely short thickening time. High initial strength.	Severe lost circulation. Thickens as it is pumped into loss channels . . . for shallow wells.
SALT BRINE CEMENT	Portland or Pozmix cement and sodium chloride, pre-mixed to give saturated solution when water is added.	Provides a saturated salt brine slurry. Does not dissolve additional salt from formation.	Primary or remedial cementing of producing wells or storage wells in salt formations.

ADDITIVES

PRODUCT	CEMENTS TO WHICH ADDED	PROPERTIES IMPARTED	APPLICATIONS
MUD-KIL	Portland cement Pozmix cement Pozmix 140	Neutralizes retarding effects of quebracho and other tannins, starch, sodium, carboxymethyl cellulose, lignite commonly found in drilling muds.	Best for jobs requiring small amounts of cement, such as open-hole plug-back, liners, squeezing, tail-out primary cementing.
HI-DENSE	Portland cement, Pozmix cement, Pozmix 140, retarded cement	Increases slurry density.	Control high-pressure oil and gas zones.



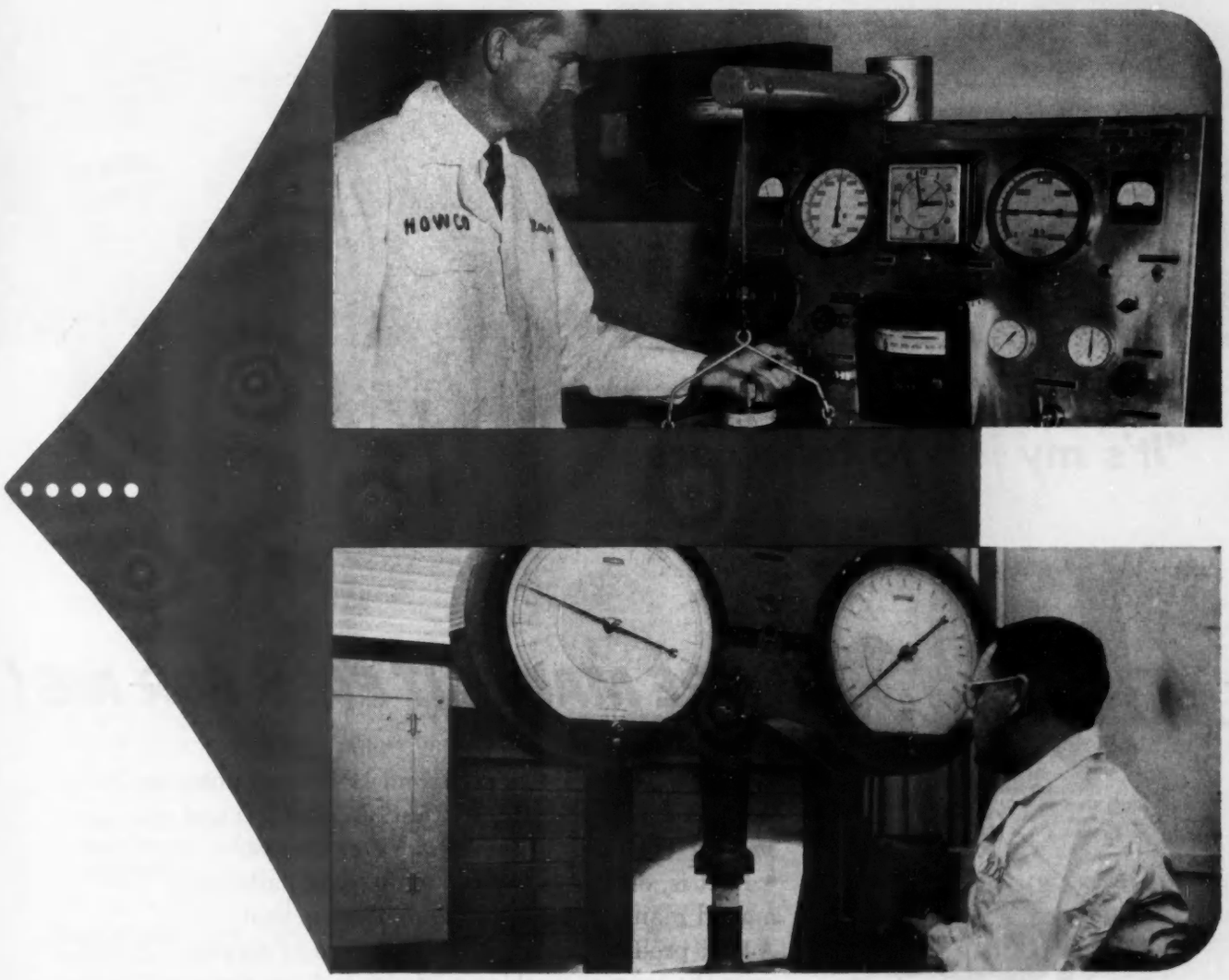
HALLIBURTON

OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

...TRADITIONALLY HALLIBURTON

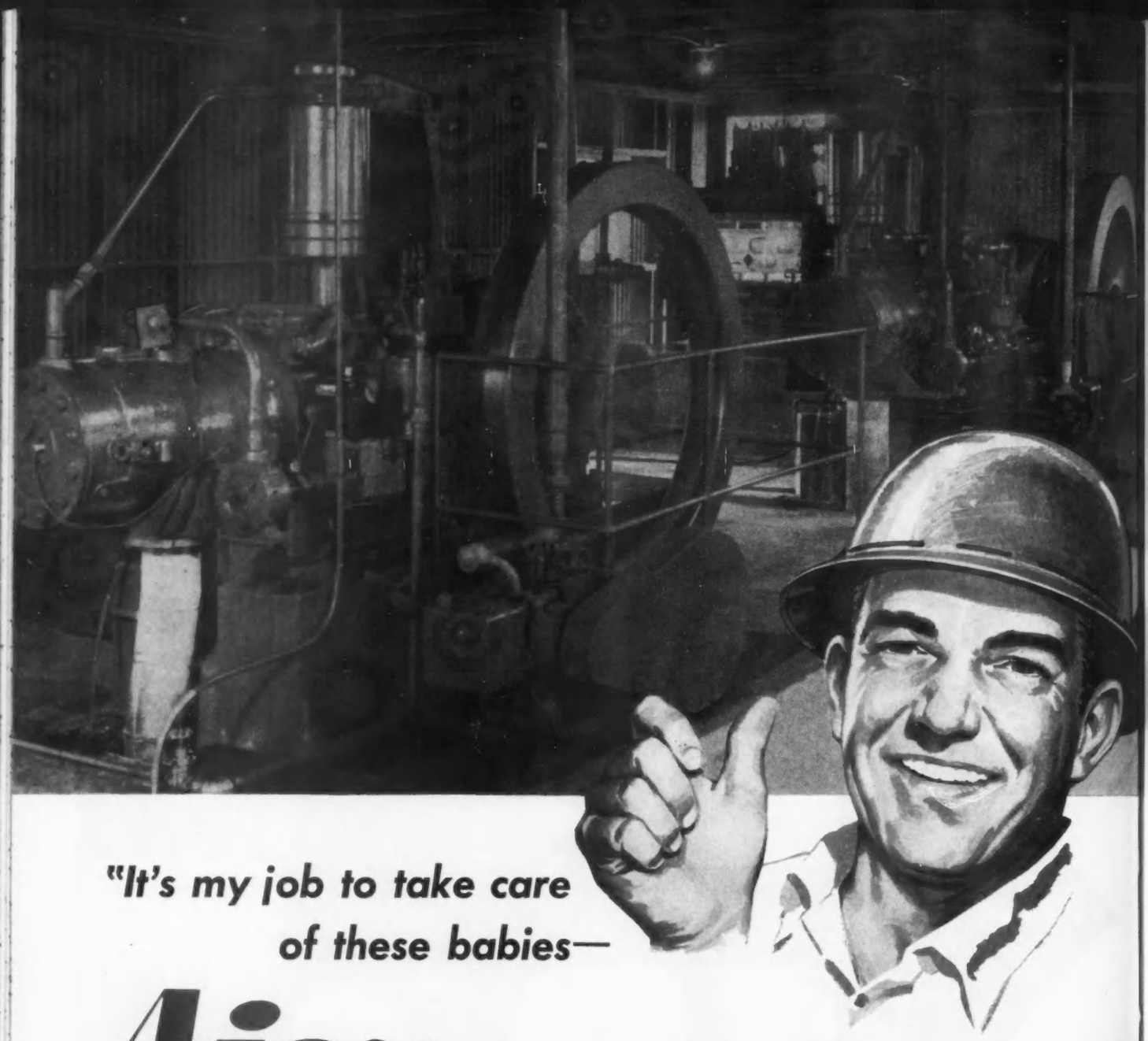
Putting cement chemistry at the service of oilmen, Halliburton develops and supplies cements and additives aimed at meeting every well condition that can be remedied by known cementing methods.



CEMENTING SERVICES

251 SERVICE CENTERS — MINUTES AWAY FROM ANY RIG

For more data on advertised products, use Readers' Service Cards, last page.



"It's my job to take care of these babies—

—Ajax SURE MAKES IT EASY FOR ME!"

We build Ajax Gas Engines and Pressure Pumps so that they need almost no attention. *Feed 'em and smile at 'em*, we like to say—*they'll do the rest.*

• Fact is, of course, all fine equipment calls for a good man to care for it. Our point is that AJAX products ask for the minimum of service, over the longest working periods, and are the easiest to handle in any man's experience.

Ask your Supply Man!

AJAX

- **GAS ENGINES**
- **PRESSURE PUMPS**

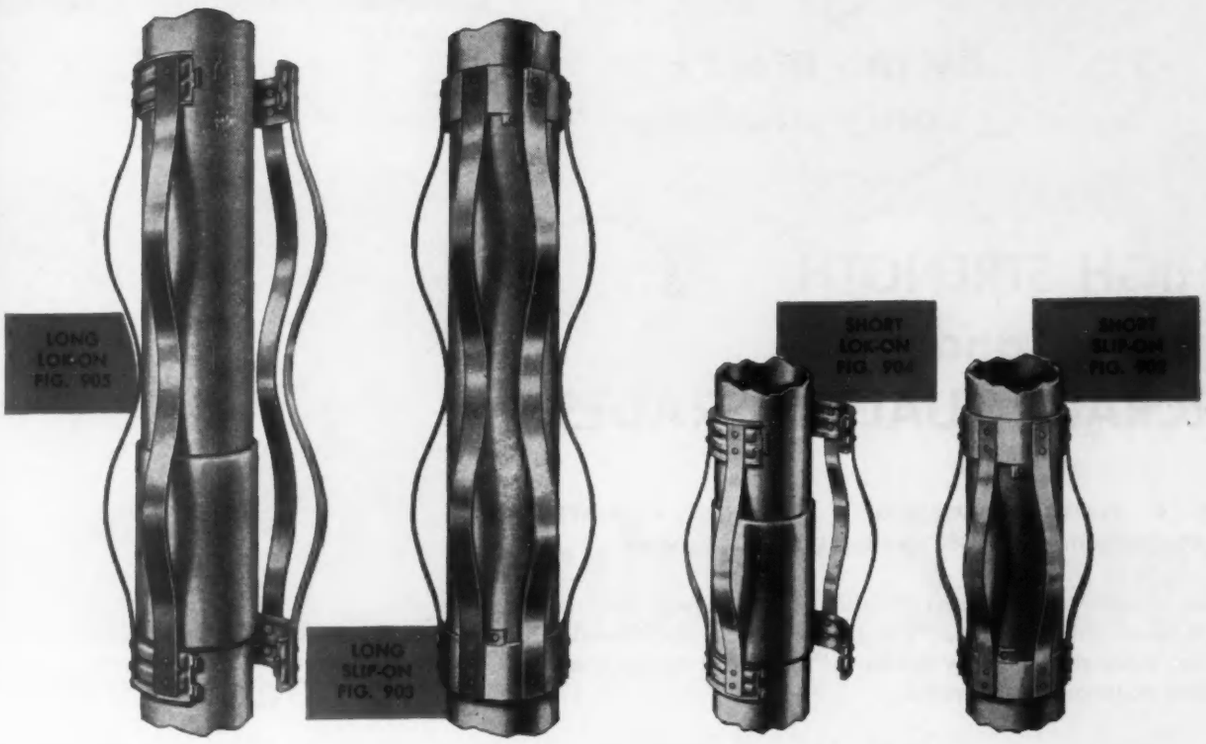
AJAX IRON WORKS

Builders of GAS AND OIL ENGINES, PRESSURE PUMPS, STEAM DRILLING ENGINES, INDUSTRIAL STEAM ENGINES

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA.
R. B. MOORE SUPPLY CO., BOLIVAR, N.Y. • BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA

LARKIN
EXCEEDS EVERY KNOWN REQUIREMENT FOR CENTRALIZER PERFORMANCE



The double-bow design of the Long Larkin Centralizer, in both the Slip-On and Lok-On Types, gives you the maximum in centralizer performance.

Based on established standards these centralizers

Take 45% less permanent set than maximum allowed*
Exert 300% more initial centering force than minimum required*

FIVE RANGES

Each of the four different types of Larkin Centralizers come in five different ranges. Therefore, there is a Larkin Centralizer "tailor made" to give maximum performance in any casing/hole size combination. The "tailor made" feature also assures easy starting at all times.

The Short Larkin Slip-On and Lok-On Centralizers fill the requirements of efficiency and economy in shallower areas or on short strings in undeviated holes.

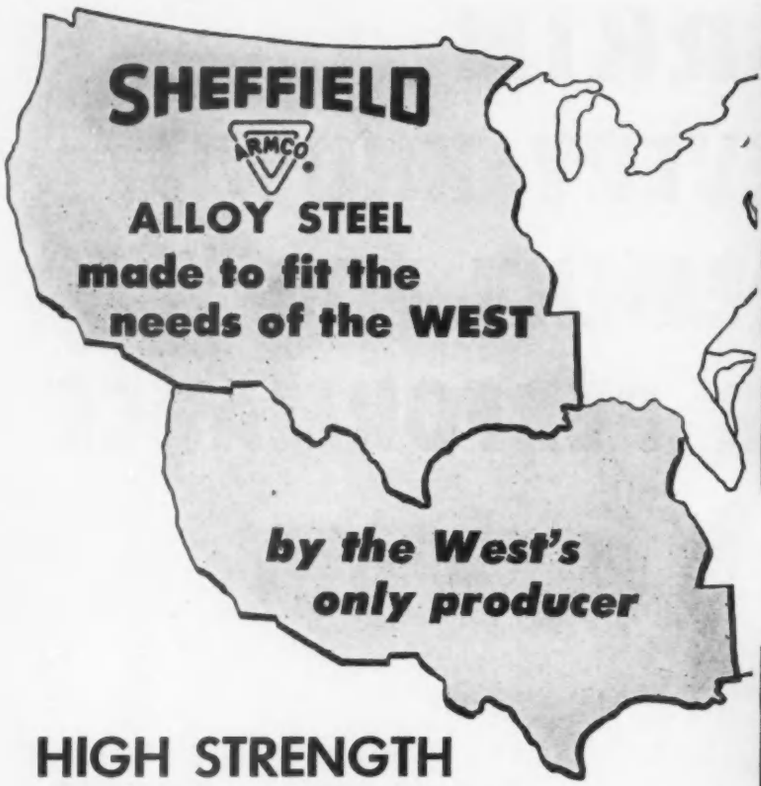
*Certified by an independent engineering firm which tested Larkin Centralizers after an extensive survey of Oil Company standards for centralizer performance.

LARKIN
...Through Your Supply Store

PESA
PARTNERS IN PETROLEUM PROGRESS

LARKIN PACKER COMPANY, INC.,
WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE



HIGH STRENGTH and AIRCRAFT QUALITY GRADES

available in

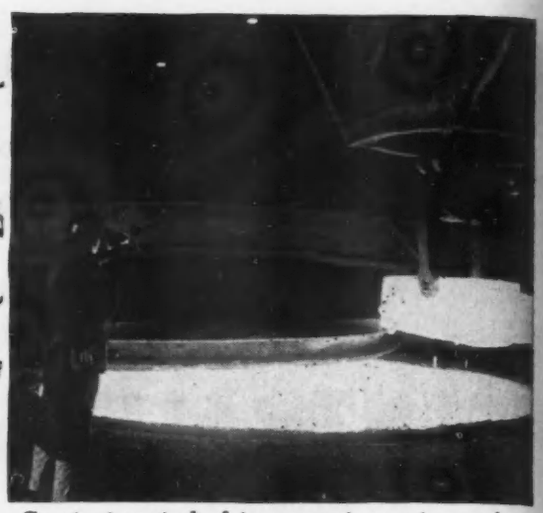
STRIPS • PLATES • ROUNDS • SQUARES • FLATS
ROUND-CORNERED BARS AND BILLETS • BLOOMS

Marvels of modern metallurgy, Sheffield Alloy Steels provide strength-to-weight ratios that (in the higher tensile-strength brackets) make steel actually lighter for the load it carries than any other commonly used metal.

A fact literally worth its weight in gold! For example, excess weight in aircraft costs around $500 a pound in terms of maintaining strength and economical operation. That's just about the going price of gold.

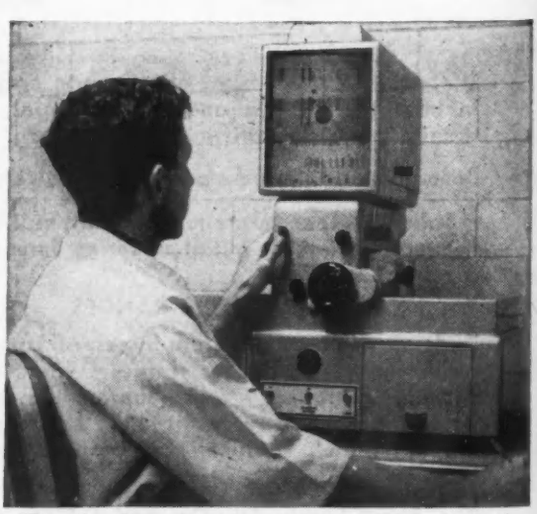
Not only in aircraft, but in countless other steel uses, Sheffield Alloy Steels add strength without adding weight. That means better products and better values for everybody. To bring this about, alloy steels must be made precisely to formula. Sheffield makes it a sure thing — with the most advanced testing procedures at every step from furnace to finished steel.

If you're a manufacturer of any product using alloy steels, you'll find the metal tailored to your needs in Sheffield High-Strength, Shef-Ten, Forging and Aircraft grades. Sheffield's strategic locations make possible service and buying advantages which will interest you. Get in touch with us.



Constant control of temperatures to precise specifications is a vital part of making alloy steels. The metallurgist above is making a quality control check of an ingot, using a sensitive optical pyrometer.

Micro-examination of steel samples is one of many checks Sheffield uses to guard the quality of Sheffield Alloy Steels.



The densitometer gives spectographic analysis of steel samples—measuring the density of the spectrum lines to determine the amount of each chemical element present.

SHEFFIELD DIVISION ARMCO STEEL CORPORATION

SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA — OFFICES IN PRINCIPAL CITIES

Ends this risky task

BJ Power Tubing Spider

faster, surer, safer than hand slips!

INCREASES PERSONNEL SAFETY. Completely eliminates dangerous hand-setting. Slips are pressure-raised and pressure-set by the driller or tong man by a remote control pedal.

SPEEDS OPERATION. No physical effort or wasted motion. Eliminates need for back-up tong. Slips lock in *up* position while the stand is being run. Setting action automatically centers tubing.

EASY ON TUBING. Slips have an instant, positive grip . . . with minimum marking of tubing and without crimping.

HANDLES THREE TUBING SIZES. The BJ power tubing spider can accommodate 2⅜, 2⅞ and 3½" o.d. tubing strings with just a simple change of the unitized slip assembly.

VERSATILE. Slips can operate efficiently on tubing strings with gas-lift valves. With a minor adjustment, they work equally well with parallel strings. The spider speeds such operations as well completion, clean-out, workover and slim-hole drilling.

TWO SIZES AVAILABLE. Medium weight (50-ton capacity) is for depths to 10,000 feet and 50-psi working pressure. Heavyweight (75-ton capacity) has extra-long nine-inch slips. Working pressure, 60 psi.

CHOICE OF POWER SOURCES. Pneumatic- or hydraulic-powered models available. Can operate off rig pressure system or by BJ auxiliary trailer-mounted air-compressor or hydraulic-power unit.

COMPATIBLE WITH OTHER POWER TOOLS. This tool is a natural power partner to the BJ Powairmatic or Hydratorc tong for fast, efficient make-up and break-out of tubing and lightweight pipe.

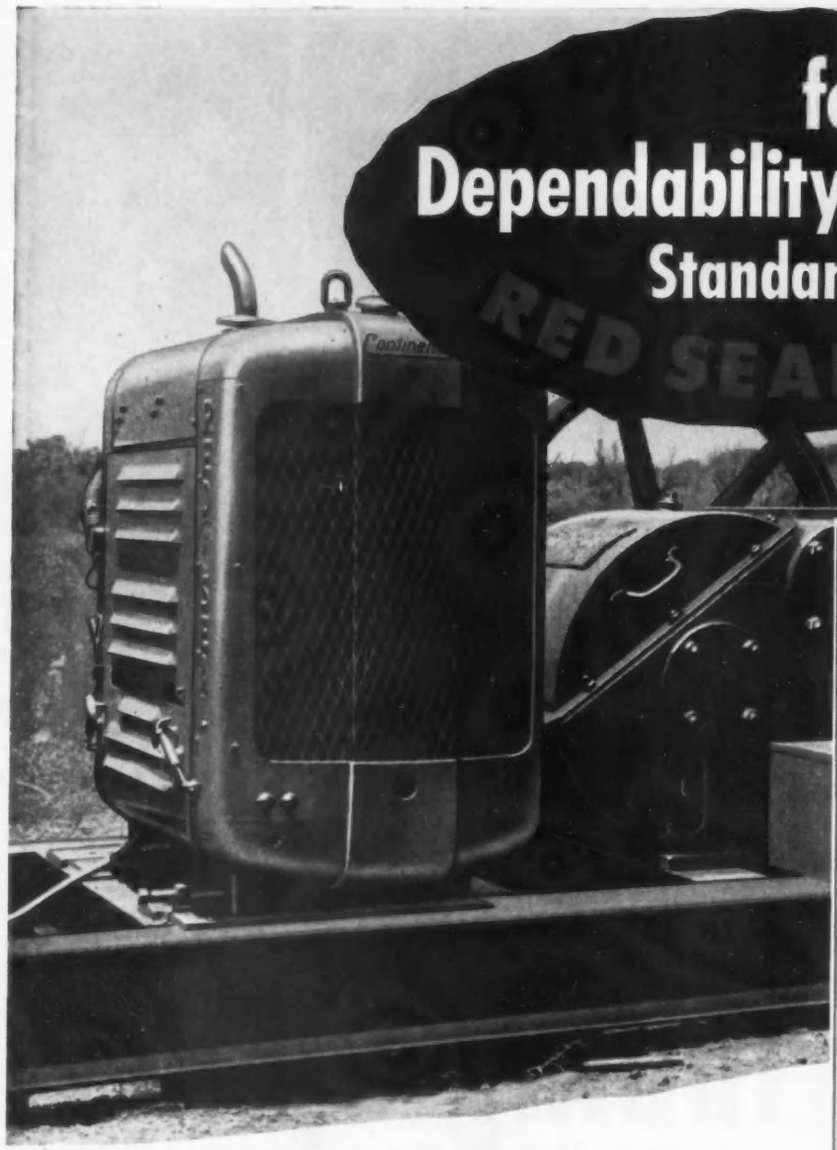
WATCH BJ FOR THE NEWEST

Byron Jackson Tools, Inc.

A SUBSIDIARY OF BORG-WARNER CORPORATION

P.O. Box 2017A, Terminal Annex, Los Angeles 54, California • Cable: "BJTOOL"
Export Address: 580 Fifth Avenue, Suite 510, New York 36, New York

for Dependability and Economy Standardize on RED SEAL POWER



A product of more than 55 years' specialized experience, Continental Red Seal oil field power embodies an array of quality features—many of them exclusive—that make for dependability, economy and long trouble-free life. The Red Seal Model F-162 shown above, operating in Stonewall County, Texas, replaced another Red Seal which had been in pumping service continuously for eight years. . . . Red Seals are engineered for every oil field application. They are available at closely-spaced power levels, for use on all standard fuels. Ask your oil field supply store or get in touch with your nearest Continental office.

• • •

GASOLINE AND LPG ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N56	4	2¼	3½	56	14.4 @ 2200 RPM
N62	4	2⅜	3½	62	15.3 @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3 3/16	3½	112	32.0 @ 2400 RPM
F124	4	3	4⅜	124	36.5 @ 2400 RPM
F140	4	3 3/16	4⅜	140	42.0 @ 2400 RPM
F162	4	3 7/16	4⅜	162	49.0 @ 2400 RPM
F186	6	3	4⅜	186	60.5 @ 2400 RPM
F209	6	3 3/16	4⅜	209	68.0 @ 2400 RPM
F226	6	3 5/16	4⅜	226	73.0 @ 2400 RPM
F244	6	3 7/16	4⅜	244	79.0 @ 2400 RPM
M271	6	3⅝	4⅜	271	86.2 @ 2400 RPM
M290	6	3¾	4⅜	290	92.2 @ 2400 RPM
M330	6	4	4⅜	330	104.4 @ 2400 RPM
M363	6	4	4 13/16	363	128.9 @ 2800 RPM
B371	6	4⅛	4⅝	371	110.0 @ 2400 RPM
B427	6	4 5/16	4⅞	427	127.0 @ 2400 RPM
G134	4	3⅛	4⅜	134	34.2 @ 2000 RPM
G157	4	3⅜	4⅜	157	40.0 @ 2000 RPM
E201	4	3⅝	4⅞	201	65.4 @ 2400 RPM
H227	4	3⅝	5½	227	54.0 @ 1800 RPM
H243	4	3¾	5½	243	57.9 @ 1800 RPM
H260	4	3⅞	5½	260	62.0 @ 1800 RPM
H277	4	4	5½	277	66.4 @ 1800 RPM
K363	6	4	4 13/16	363	123.0 @ 2400 RPM
J382	4	4½	6	382	74.0 @ 1400 RPM
T371	6	4⅛	4⅝	371	119.0 @ 2400 RPM
T427	6	4 5/16	4⅞	427	140.0 @ 2400 RPM
U501	6	4½	5¼	501	159.0 @ 2400 RPM
R513	6	4½	5⅓	513	164.3 @ 2400 RPM
R572	6	4¾	5⅓	572	182.4 @ 2400 RPM
R602	6	4⅞	5⅓	602	191.7 @ 2400 RPM
V603	8	4¾	4¼	603	220.0 @ 2800 RPM
S749	6	5⅛	5½	749	217.0 @ 2200 RPM
S820	6	5⅛	5½	820	237.0 @ 2200 RPM

CUSHIONED POWER DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
ZD129	4	3¼	3⅞	129	34.0 @ 2000 RPM
GD157	4	3⅜	4⅛	157	39.0 @ 2000 RPM
*ED201	4	3⅝	4⅞	201	45.8 @ 2000 RPM
HD243	4	3¾	5½	243	55.0 @ 2000 RPM
*HD260	4	3⅞	5½	260	59.0 @ 2000 RPM
*HD277	4	4	5½	277	63.2 @ 2200 RPM
*JD382	4	4½	6	382	72.5 @ 1600 RPM
TD427	6	4 5/16	4⅞	427	106.0 @ 2000 RPM
RD572	6	4¾	5⅓	572	154.0 @ 2000 RPM
VD603	8	4¾	4¼	603	175.0 @ 2600 RPM
SD802	6	5 5/16	5½	802	202.0 @ 1800 RPM

*Available for industrial applications only.

SERVICE FACILITIES AND GENUINE RED SEAL PARTS AVAILABLE EVERYWHERE

CONTINENTAL MOTORS ® Powerful as the Nation AMERICA'S STANDARD

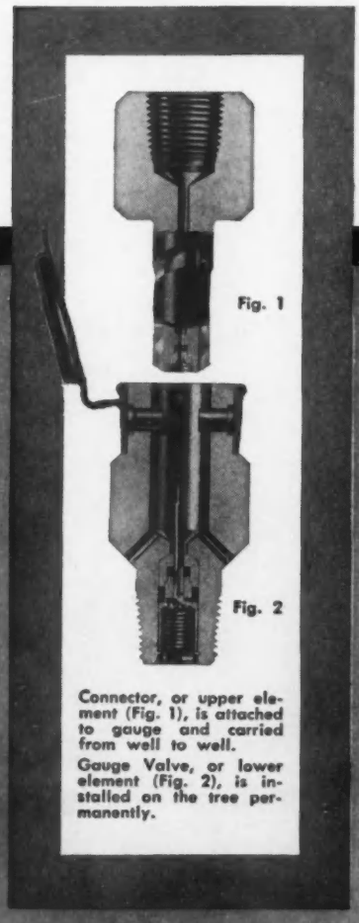
Continental Motors Corporation

MUSKEGON, MICHIGAN

WORLD'S LEADING INDEPENDENT MANUFACTURER OF INTERNAL COMBUSTION ENGINES, CONTINENTAL MOTORS OPERATES PLANTS IN ATLANTA, DALLAS, DETROIT, MILWAUKEE, MUSKEGON, AND TOLEDO, AND IN ST. THOMAS, ONT., PRODUCING AIR-COOLED AND LIQUID-COOLED ENGINES FOR USE ON LAND, AT SEA AND IN THE AIR.

No exposure to elements
No danger of breakage, intentional or otherwise
Save the money you are now spending for gauge repairs
No investment in permanently installed gauges

How to make ONE Christmas tree gauge do the work of MANY



Connector, or upper element (Fig. 1), is attached to gauge and carried from well to well.

Gauge Valve, or lower element (Fig. 2), is installed on the tree permanently.

U. S. Patent No. 2,618,978

GAUGE VALVE AND CONNECTOR, THE MODERN, ECONOMICAL WAY TO OBTAIN ACCURATE WELL PRESSURES

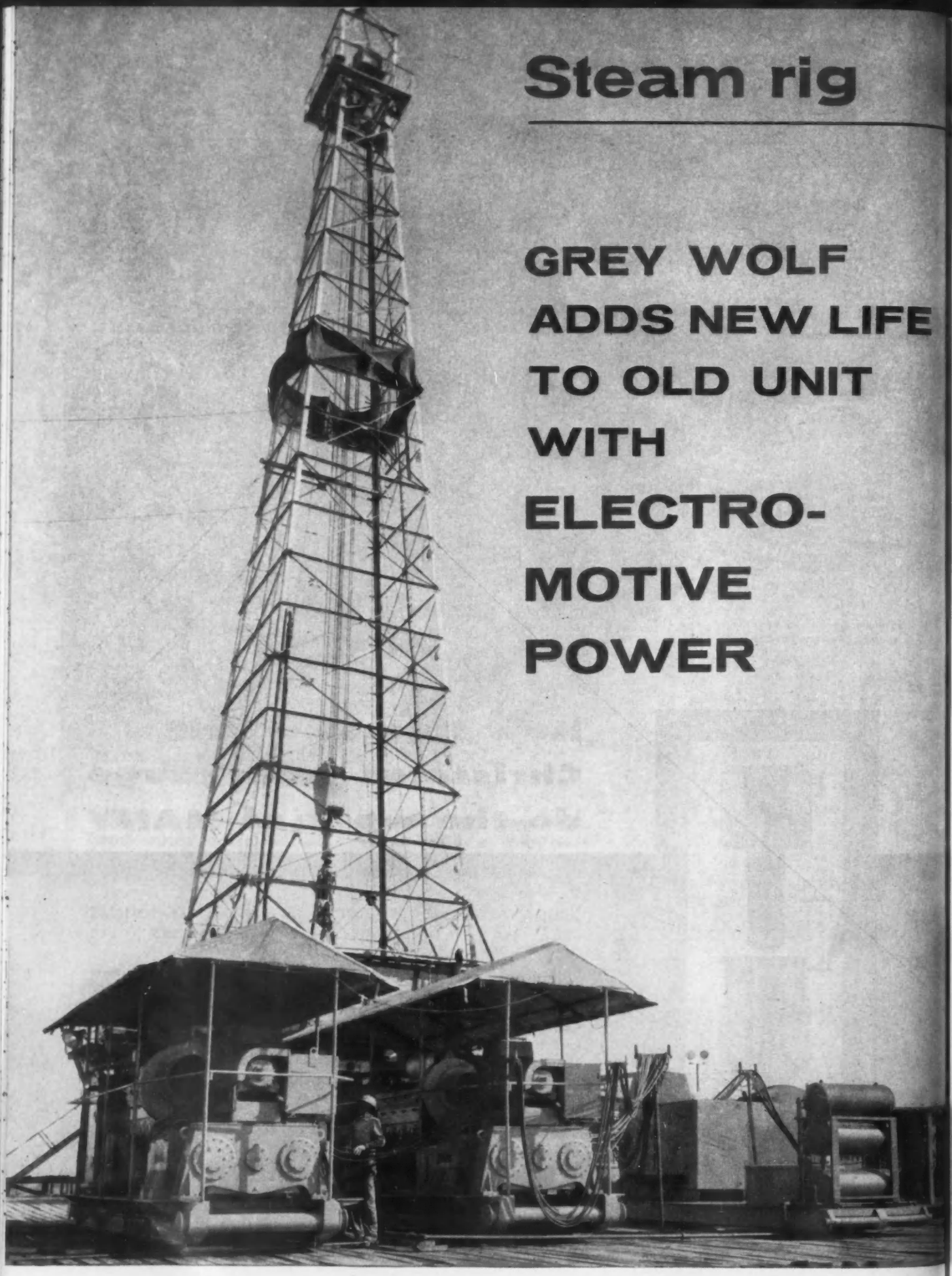
Instead of one, two, or more pressure gauges to the tree, now all you need is **one gauge per gauger.** Where you would ordinarily install a gauge and valve, simply install a Thornhill-Craver Gauge Valve (Fig. 2). To obtain a pressure reading, just insert a calibrated gauge with Connector (Fig. 1) in the Gauge Valve. Half a turn engages a J-Tool and opens the valve, exposing the gauge to well pressure. Remove the gauge and the valve closes automatically. Since a single gauge is used for any number of wells, that gauge may be checked and calibrated frequently to insure accurate pressure readings for all wells. No gauge inventory. No breakage. No replacements. No repairs. Safe and easy to use. Stainless steel throughout.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

UNIBOLT
THE ONE BOLT COUPLING

Steam rig

GREY WOLF ADDS NEW LIFE TO OLD UNIT WITH ELECTRO-MOTIVE POWER



Two skid-mounted Electro-Motive 875-hp generating sets power Grey Wolf's recently converted rig. Each 8-cylinder engine drives two 500-kw dc generators that supply power to electric drive motors on draw works, rotary and mud pumps. Electrical control cabinet is located on skid to right of engines.

converted to Diesel-Electric

Grey Wolf Drilling Company of Houston expects its newly converted Diesel-Electric rig will cut rig-up time to three days—just half the time it took with the old steam unit.

In addition, "trips" are faster with the new rig and drilling speeds were judged faster on two locations where depths up to 13,000 feet were reached. Maximum drilling depth is well beyond 17,000 feet.

Why Diesel-Electric?

Grey Wolf saw two distinct advantages: Diesel-Electric would adapt readily to present components, thus reduce costs; and because components are connected by flexible electric cables, the rig could be broken into skid-mounted packages for fast transport and quick rig-up.

Why Electro-Motive Power?

A "packaged" system was one reason Grey Wolf decided on Electro-Motive Power. For this system is designed and built to work together—one manufacturer—one source of responsibility. Other reasons were the accurate control and torque characteristics of Electro-Motive Power plus its demonstrated economies of long life and low maintenance on both land and offshore rigs.

Have you considered the advantages of Diesel-Electric for your drilling operations? Contact your Electro-Motive Representative for complete details.

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS • La Grange, Ill.
In Canada: General Motors Diesel Limited, London, Ontario
Petroleum Industry Sales Offices: Dallas and Houston, Texas; Morgan City, Louisiana; Los Angeles, California.

View from derrick floor shows simple arrangement of components on ground. Single 625-hp dc electric motors drive mud pumps. Electric cables run from generating units to various motors on overhead runways. Flexible cables permit placing equipment to fit location conditions.

Driller's control stand provides maximum visibility for every operation. Simple, sensitive controls provide smooth and rapid acceleration of loads with positive control of speed and torque. From this one panel, driller has complete control of all Diesel-Electric equipment.

In carrier landings, planes coming in at more than 100 knots are stopped in a split second. This amazing performance is made possible by having each plane hook onto one of several wire ropes stretched across the flight deck. Both plane and rope receive an almost unbelievable shock at the moment of contact. Needless to say, only top-quality wire ropes can be used for this application because . . .

you can't bargain with safety

While your use of wire rope differs from this carrier application, *safety should be just as important to you.* For, although a "bargain" rope may save you money, it can cost you your peace of mind. So don't bargain with safety. Buy a rope that's a *quality* rope—buy Wickwire Rope. 5049

WICKWIRE ROPE — A CF&I PRODUCT

CF&I

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WICKWIRE SPENCER STEEL DIVISION—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New Orleans
New York • Philadelphia

For more data on advertised products, use Readers' Service Cards, last page.

Du Pont announces... new HIGH viscosity CMC for drilling muds

Now you can control both fluid loss and viscosity in those areas where *low-solids* muds are commonly used—areas like West Texas and New Mexico.

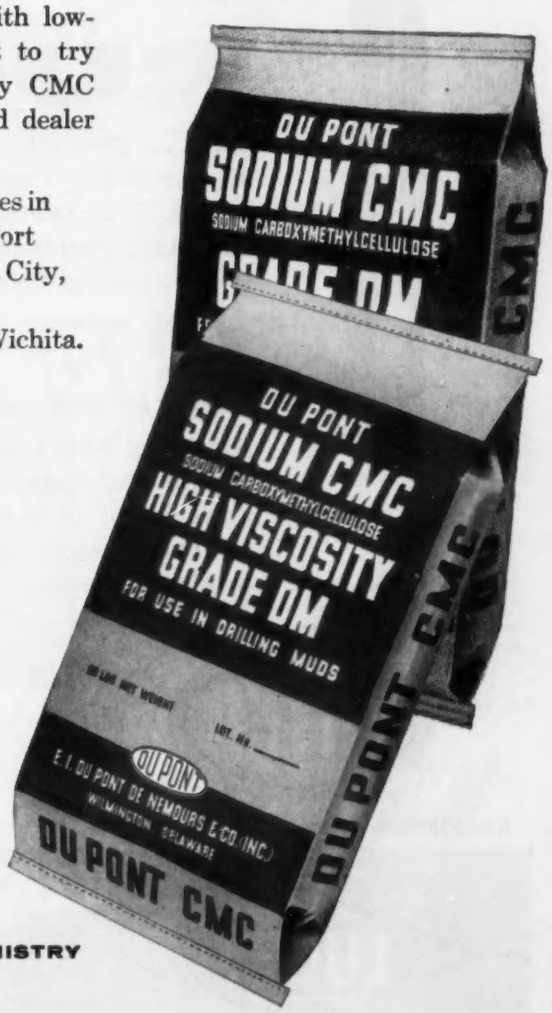
Du Pont's new *HIGH viscosity* CMC is specifically formulated to meet your need for a low-cost mud additive *which increases viscosity of low-solids muds in addition to reducing water loss.*

Now, with two different viscosity grades, Du Pont CMC for drilling muds is more versatile and useful than ever . . . gives you:

1. Broad viscosity control
2. Low-cost control of fluid loss
3. Thin, tough filter cake
4. Muds of improved stability
5. Improved suspending action
6. Improved emulsifying action
7. Versatile application in a variety of muds

If you are working with low-solids muds, you'll want to try this new HIGH viscosity CMC now. Ask your local mud dealer for it, or contact. . .

- Barada & Page, Inc., offices in Corpus Christi, Dallas, Fort Worth, Houston, Kansas City, New Orleans, Odessa, Oklahoma City, Tulsa, Wichita.
- Macco Corp., Paramount, California.
- Du Pont Explosives Department offices in Dallas, Texas, Los Angeles, California, or Wilmington, Delaware.



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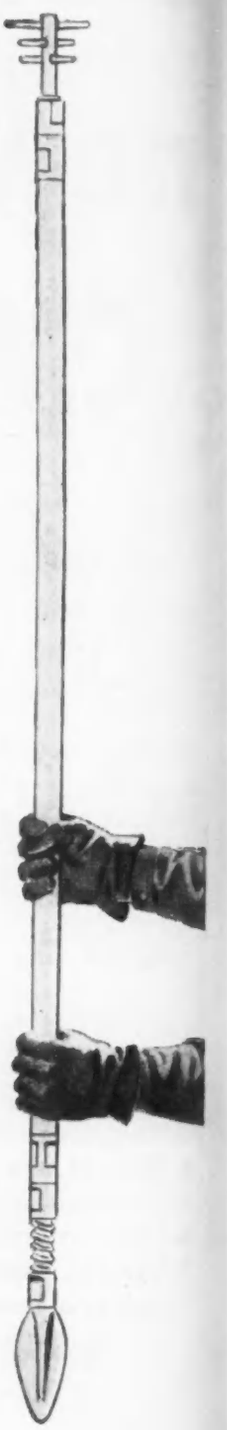

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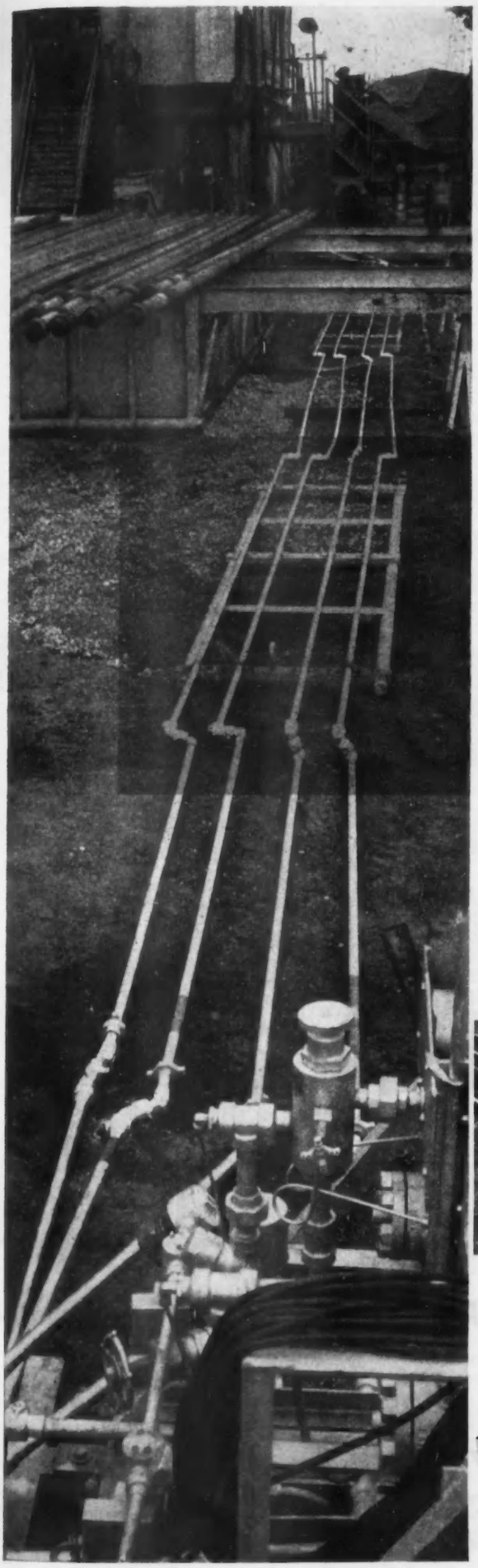
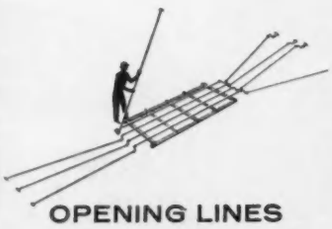
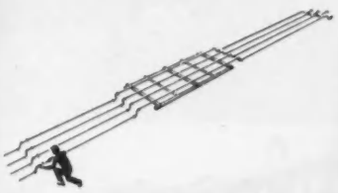


SWIVEL JOINTED ACCUMULATOR LINES CUT HOOKUP TIME 75%

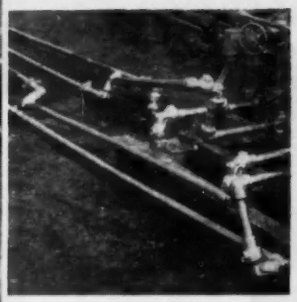
SPOTTING SLED



OPENING LINES



HOOKING UP UNIONS



Situation: Connecting hydraulic piping from accumulator to blowout preventer on this California rig used to take two men well over two hours. There were delays for rethreading damaged pipe and replacing worn fittings. And keeping lines free of dirt between breakdown and rigging-up was a problem.

Solution: Searching for a faster hookup method, the veteran toolpusher in charge of the rig drew upon his previous experience with Chiksan Swivel Joints. By combining a series of Chiksan Joints with rigid piping mounted on a sled, one man now completes the entire hookup in one hour.

Benefits: The operators estimated that the savings in time alone more than paid for the Swivel Joints in less than a year. In addition to rigging time saved, wear and tear on the piping itself has been considerably reduced. And with line pressures of 1500 psi and surges up to 2000 psi, the free-swiveling Chiksan Joints absorb pulsation and vibration eliminating downtime required to replace leaky pipe fittings.

Where to buy: Chiksan Swivel Joints are available at your nearby supply stores in a full range of styles and capacities to meet every oilfield need. If you would like a drawing of the preventer line hookup described above, please write Chiksan, Brea, California, for "Bulletin ACL-1."

Free swiveling Chiksan Swivel Joints permit flexibility in positioning accumulator, absorb line pulsations and best of all, deliver years of service with only occasional maintenance.

Please address Dept. 66

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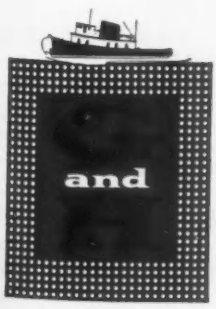
For prompt, dependable towing of anything that floats ... anytime, anywhere... call the G & H office nearest you. Experienced analysis of your offshore towing requirements, with no obligation, of course.



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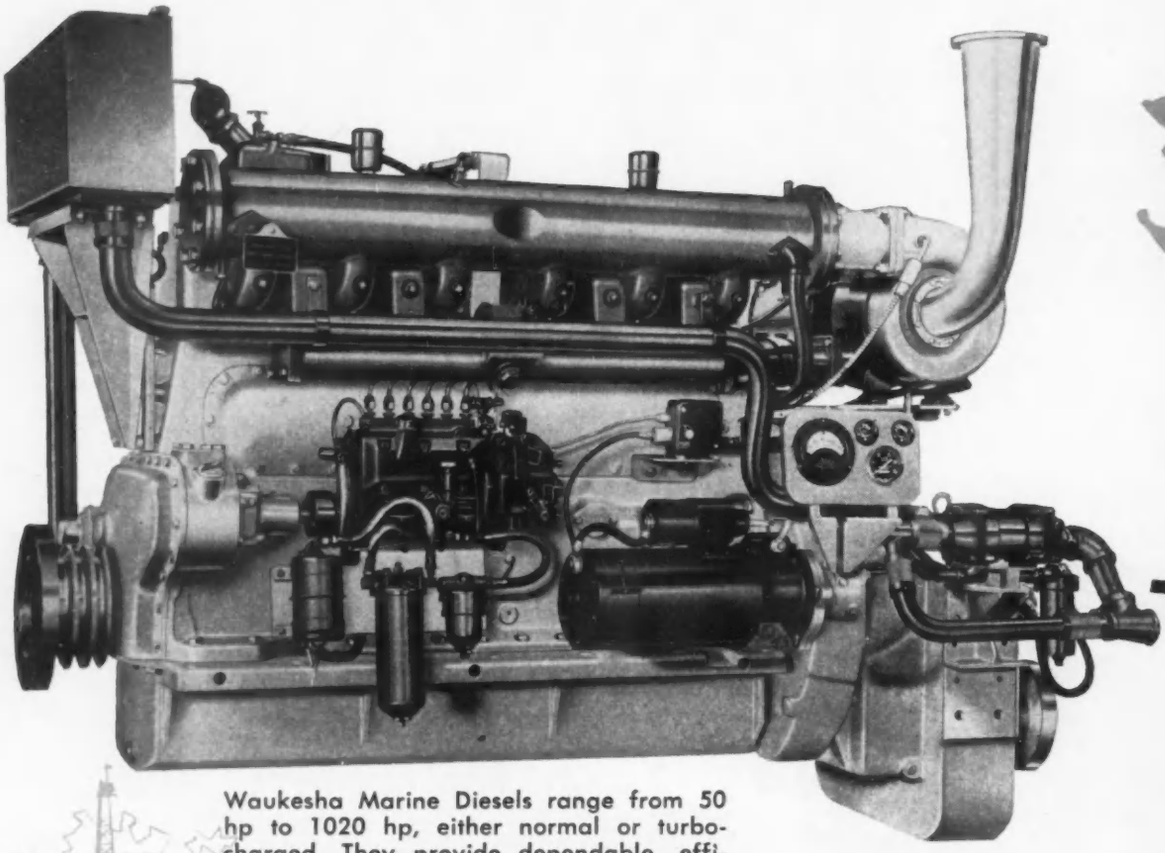
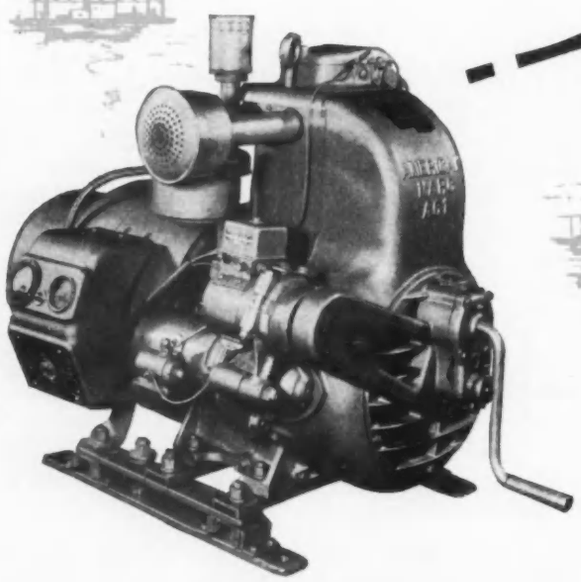


Waukesha Marine Diesels range from 50 hp to 1020 hp, either normal or turbo-charged. They provide dependable, efficient power for crewboats and towboats in the roughest industrial service. Waukesha Marine Diesels set a new standard for safety, simplicity, smoothness and economy.



American M.A.R.C. Diesel Power Units and Electric Plants were the first air cooled engines in the U.S.A. and are leaders in the small engine field. The low maintenance cost and operating economy of American M.A.R.C. Air Cooled Diesel Engines make them ideal power plants wherever a 5-15 hp requirement exists.

FloWay Turbine Pumps are excellent for a wide variety of water applications. Basic design features and improvements over conventional pump design result in maximum efficiency and trouble free operation. FloWay Pumps are especially suited for agricultural and industrial application.

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AMERICAN M·A·R·C DIESEL ENGINES

FLOWAY TURBINE PUMPS

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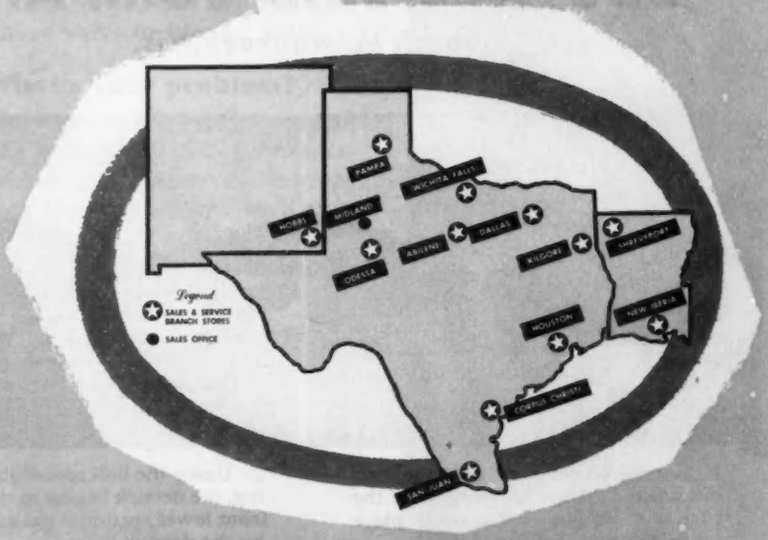
In addition to a full line of Waukesha Drilling Engines, Kohler Power Units and many other name brands, Waukesha Sales & Service, Inc. now announces the addition of three important products—a marine diesel engine, a small air or liquid cooled diesel engine and a turbine water pump—described on the opposite page. These products are among the finest in their fields.

Write for full information and service locations.



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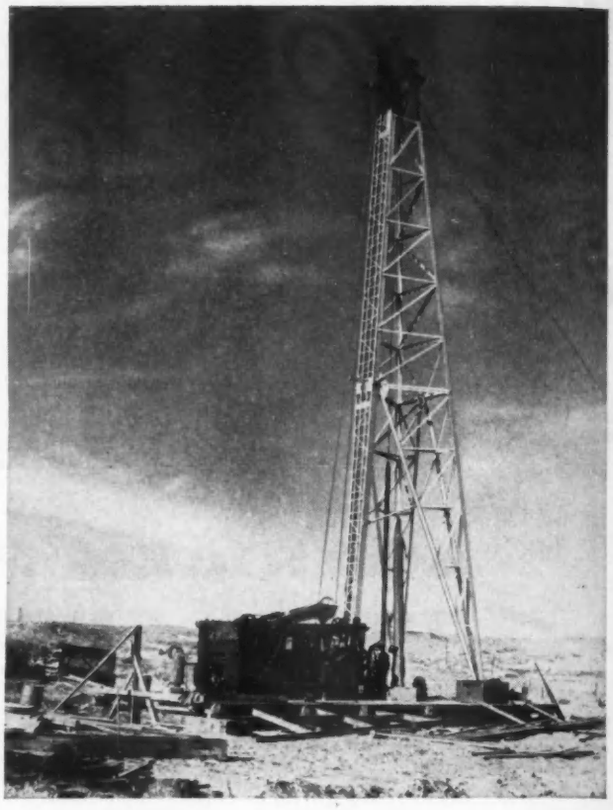
For use with both 36-L and 48-L spudders, Bucyrus-Erie's heavy-duty tripod derrick has sufficient height and stability to handle casing loads up to 300,000 pounds when rigged for 10-part hoist. Completely raised, the derrick is 70′ 4″ high.

Despite the derrick's size, spudder mobility is retained. Erected in five easy steps, this derrick is easy to tear down and move. Each of the five units can be disassembled and transported separately. Look: 45557



36-L Top-to-bottom drilling to 3,500 feet. Servicing to 4,000 feet. Swings up to 5,000 pounds of tools.

48-L Top-to-bottom drilling to 6,000 feet. Servicing to 7,000 feet. Swings up to 6,700 pounds of tools.

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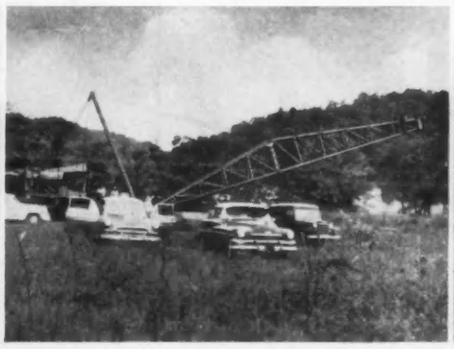
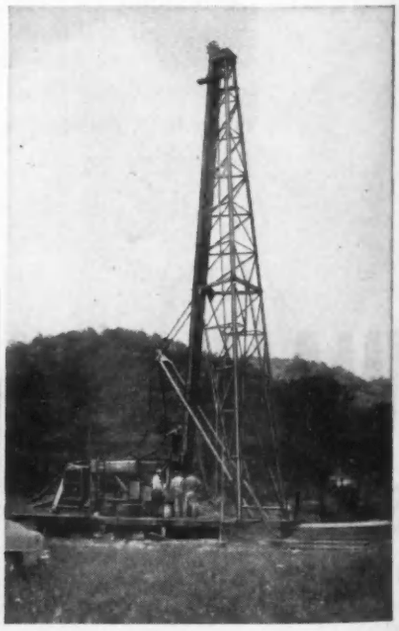
South Milwaukee, Wis.

1. Derrick sections are assembled on the ground. Legs are hinged to the base and the gin pole is set in place preparatory to raising derrick.



2. Using the bull reel drum for hoisting, the derrick begins to rise. Hinged front lower section is pulled into place by the derrick hoist.

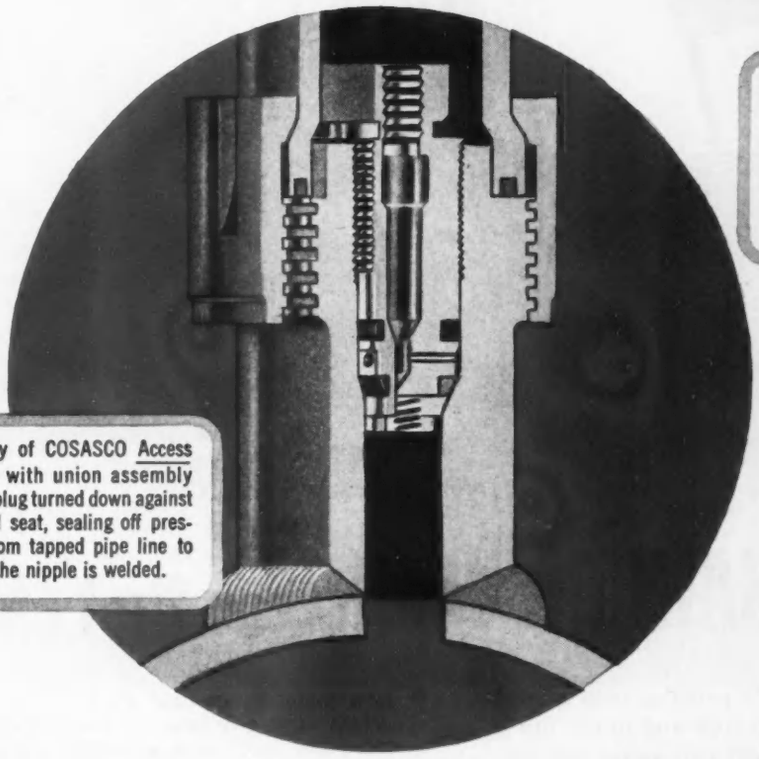


3. When the derrick is completely raised, the gin pole is removed and the front lower section is attached.

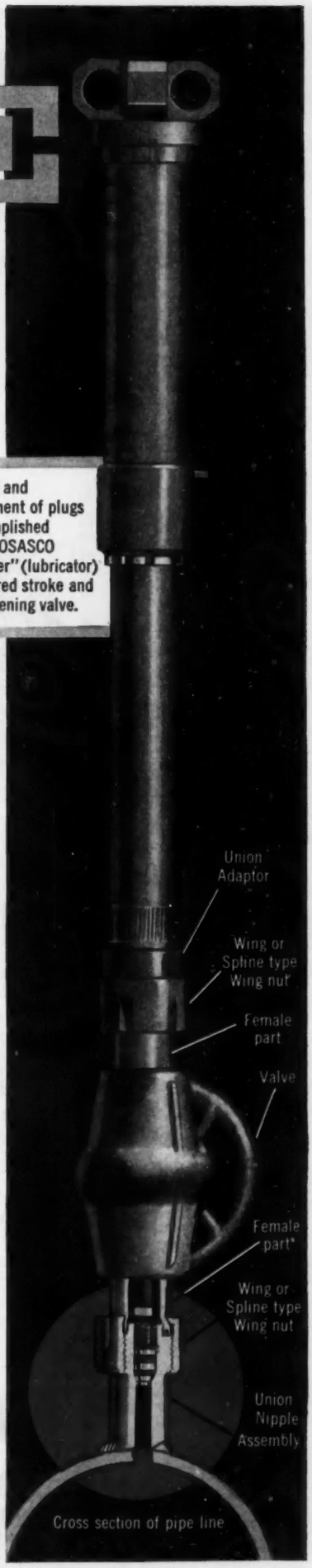
SAFE

entry against pressure

...to insert instruments, replace valves, investigate corrosion!



Cutaway of COSASCO Access Nipple with union assembly shows plug turned down against tapered seat, sealing off pressure from tapped pipe line to which the nipple is welded.



Removal and replacement of plugs is accomplished with a COSASCO "Retriever" (lubricator) of required stroke and a full-opening valve.

COSASCO *Access* Nipples give you safe and easy entry into well heads, refinery vessels, storage and transmission equipment *without interfering with operations.* They also replace expensive valves and permit removal of other externals *without loss of pressure or product!*

The COSASCO *Access* Nipple has a removable threaded plug of type 303-304 stainless steel which seals off the nipple when turned down against the tapered seat. This plug is readily replaced by special plugs for inserting corrosion coupons, water samplers, thermocouples, hydrogen probes, etc. The *Access* Nipple can also function as a gauge valve or bleeder valve.

What's your problem?

If you have an entry-against-pressure problem, we invite you to submit details. Send blue prints or drawings depicting the problem and we'll supply the COSASCO solution *without charge.* You will be under no obligation whatsoever for this service.

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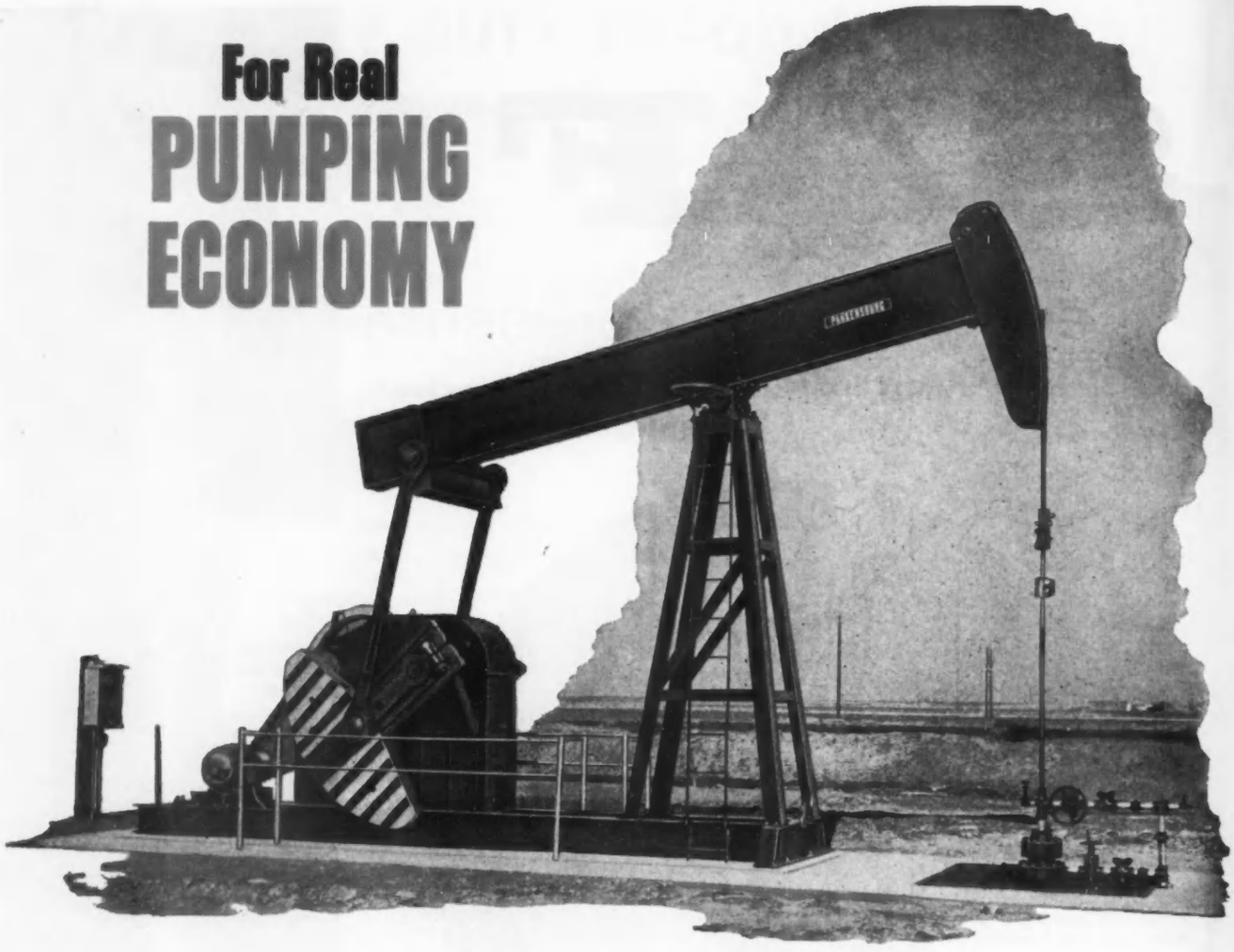

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- Parkersburg chain-driven pumping units are available in double reduction models ranging from 25,000″ lbs. to 228,000″ lbs. peak torque rating.
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At Parkersburg, quality and service have gone hand-in-hand for 60 years!

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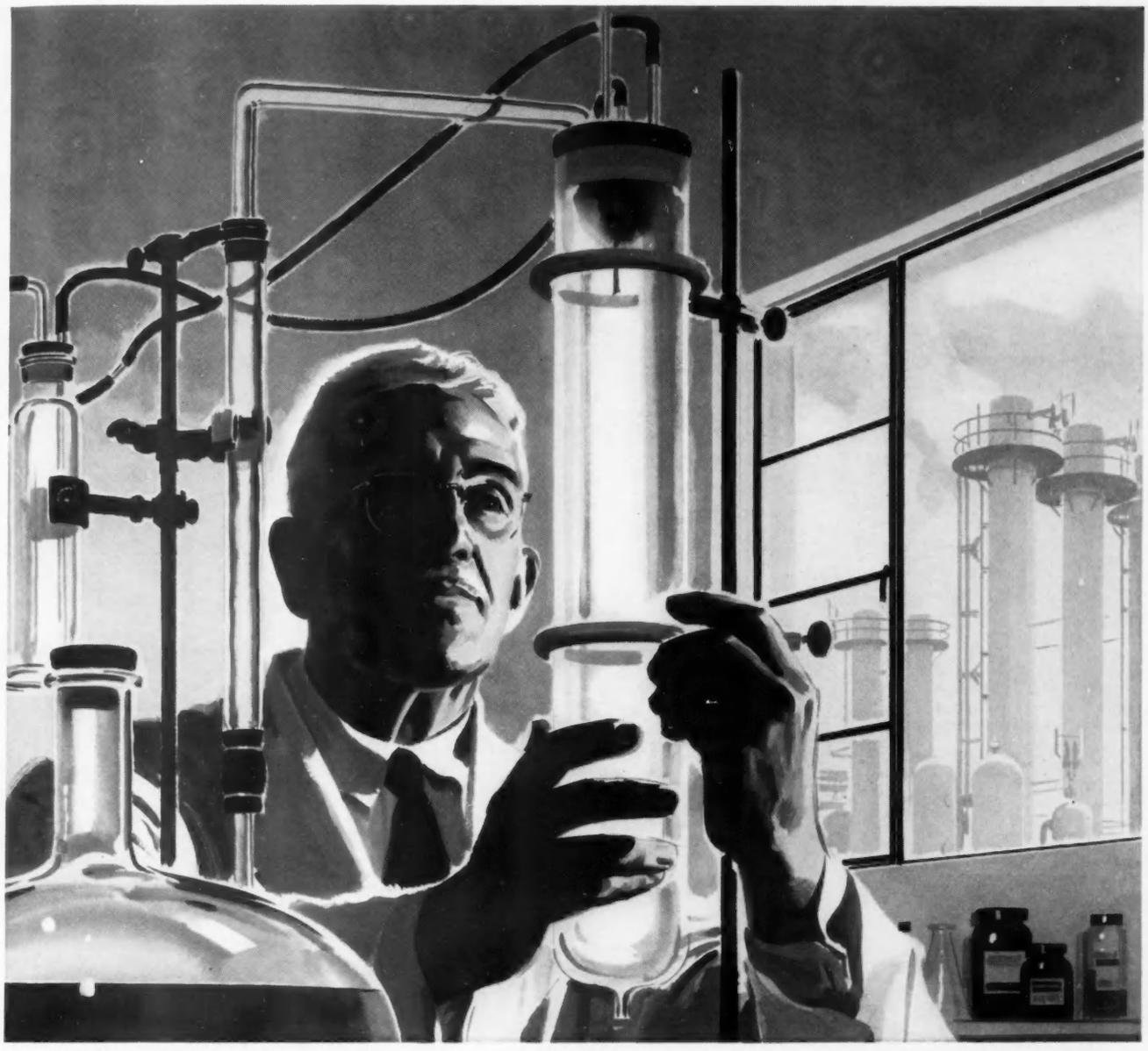

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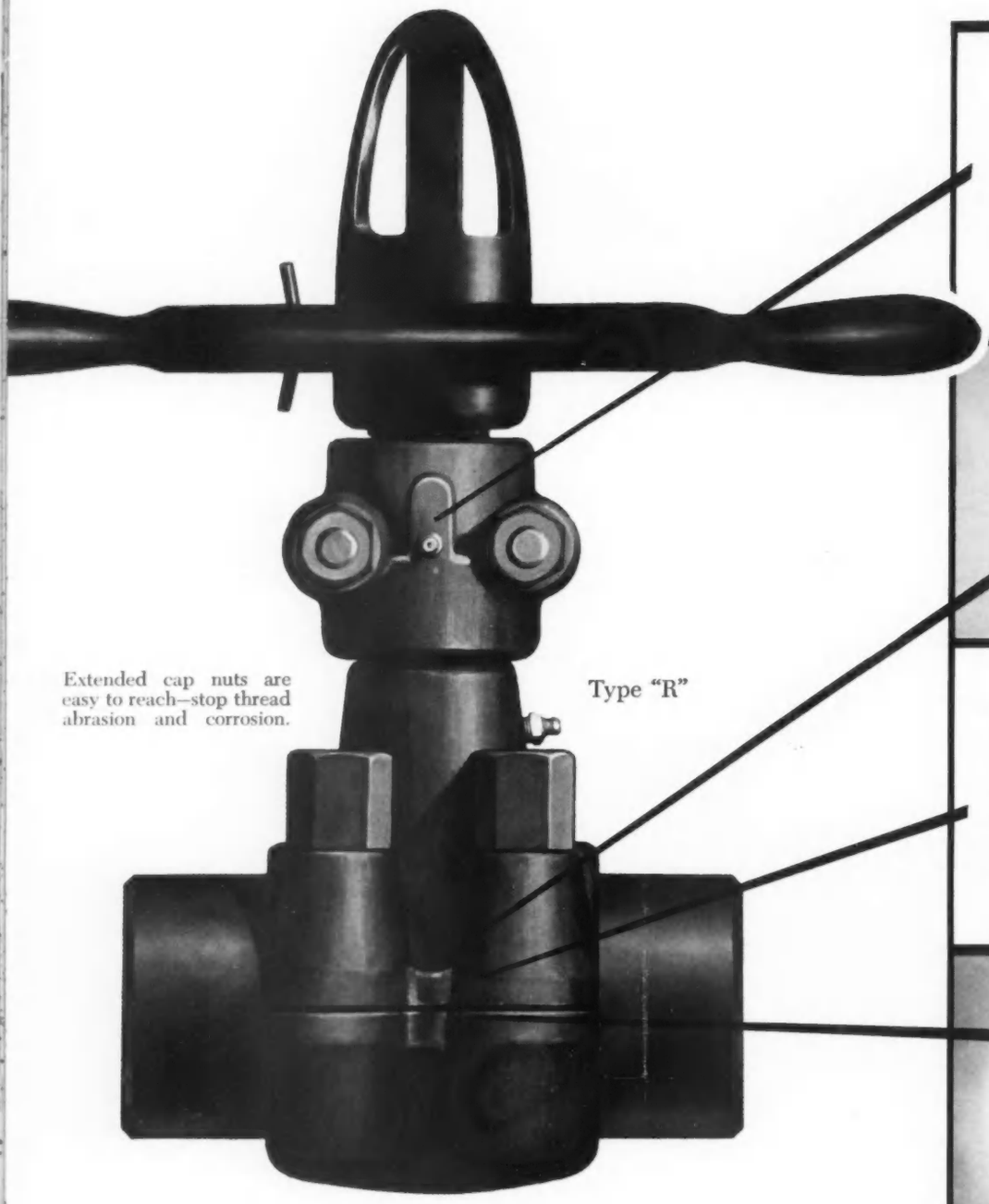


Extended cap nuts are easy to reach—stop thread abrasion and corrosion.

Type "R"

Ball-bearing stem nut on most sizes of the Type "R" affords easier operation — is interchangeable with Type "C" valves, if a Type "R" split bonnet is used.

The oversize carburized steel wear rings are sealed against the subs by "O" rings and are removed straight out with the gate packer as a unit.

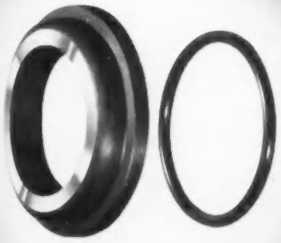
Cameron

TYPE "R" RUGGED COMPANION TO THE FAMOUS FLEX-SEAL MUD VALVE

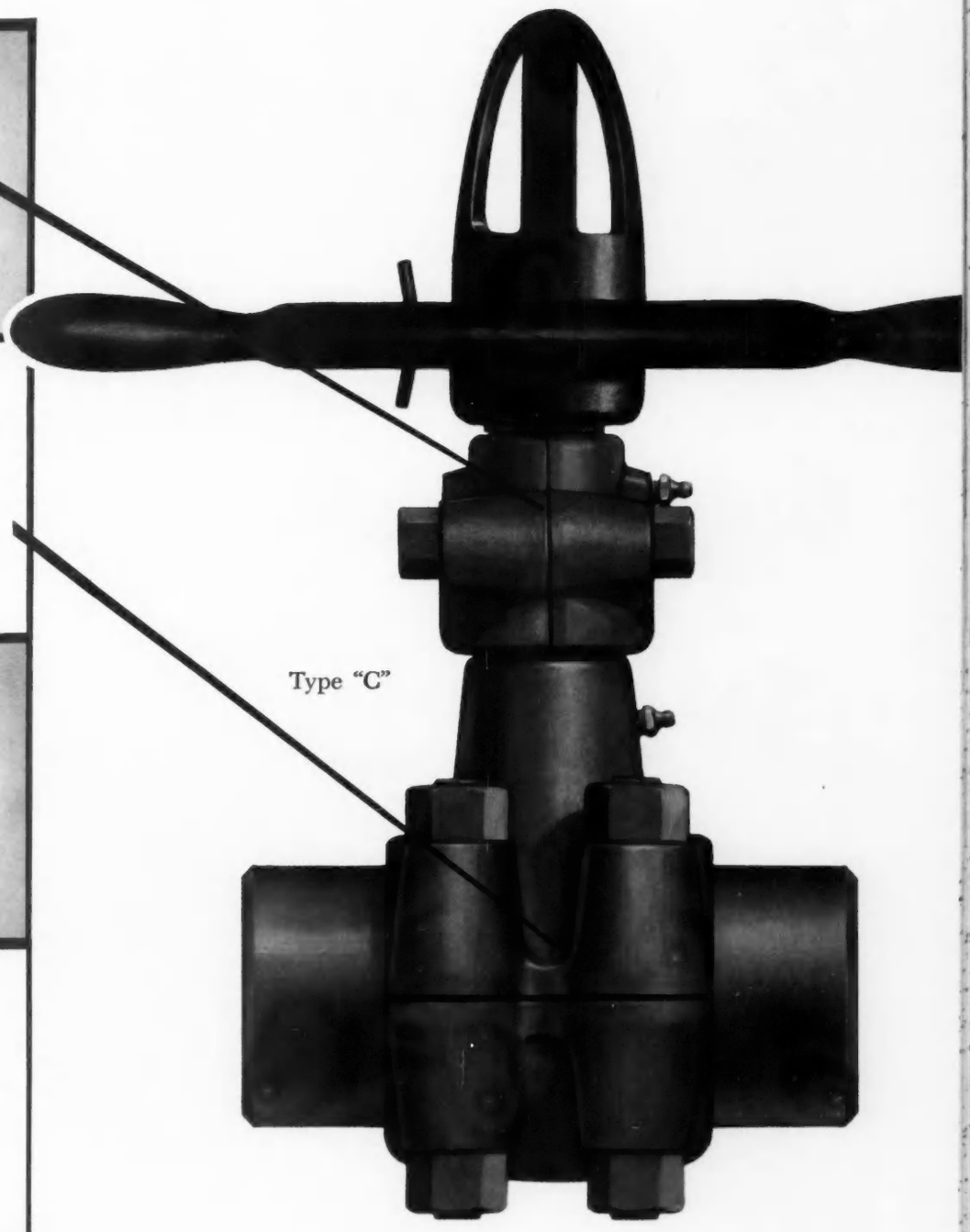
For 20 years the famous Cameron Type "C" Flex-Seal Mud Line Valve has been a standard of the drilling industry. Its rugged dependability, low maintenance and economical repair have secured its place on most drilling rigs throughout the oil world.

The increasing use of rigid mud manifolds on drilling barges, unitized power rigs and service trucks for cementing and formation fracturing has indicated the need for a companion valve. The Type "R" meets this need. Subs on the Type "R" are modified to permit the packer and wear rings to be changed as a unit without moving the subs apart as with the Type "C". With this revised construction the Type "R" subs are attached to the cap to form a rigid unit. At the same time, the subs may be changed or swivelled by removing the tack welds and replacing the worn part. The welds are structural only and not subject to pressure. Gates and packers are interchangeable between the Type "C" and the Type "R". The

Tough new compound in the big gate packer means lots more wear — fewer repairs. Replacement requires no special instructions or fixtures — no intricate positioning of gate stem threads.



Integral, welded subs and body cap make misalignment during repairs impossible. If a sub is damaged it may be separated and replaced rather than replacing an expensive body unit.



Type "C"

body and body cap may be interchanged. A ball-bearing nut assembly, standard in most sizes of the Type "R", will also fit the Type "C". Only the wear rings and subs are not interchangeable. The Type "C" may be easily converted to Type "R" by simply substituting subs, packer and wear rings.

Easy-out packer and wear ring means quick repair with no misalignment.

Cameron

IRON WORKS, INC.

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The river that flows on wheels is the 2,384,000,000 gallons of Petroleum that Santa Fe moves every year.

It's so large that it makes Santa Fe the No. 1 petroleum railroad in the country.

This flood tide of oil gives heat and power to farms, factories, military installations and homes all over the nation.

The tremendous demand for petroleum, in all its forms, poses special problems for Santa Fe. For it requires speed and service to keep that river flowing full force. Here are a few of the ways we get the job done:

We move empty tankers just as fast as full ones, so no vehicle will stand idle.

As new oil fields are opened up, we stand ready to serve them. And when new developments take place within the industry, we adapt ourselves to take care of them.

As an example, take liquefied petroleum gas. The demand for it has skyrocketed in the last 10 years, because with this "bottled gas" rural families can cook and heat with gas just like city people. And the railroads have made it possible for them to get it.

Santa Fe runs special LPG trains when the demand for this product requires it. In a year, these trains carry enough LPG to heat more than 500,000 homes from November through April.

This is just a part of the story of the dependable transportation service Santa Fe is providing to essential industries that contribute so much to the welfare of our country.

Santa Fe

Always on the move toward a better way

SANTA FE SYSTEM LINES

Serving the West and Southwest

NEW!

The Dorr-Oliver CLAYJECTOR for Controlling Weighted Muds

Latest development in controlling drill mud weights is the Dorr-Oliver ClayJector. This new unit is designed specifically for weighted muds . . . will mechanically reject undesirable drilled solids and retain the valuable barites (weighting materials) in the system. Optimum solids content is maintained at a minimum cost for barites which would be lost if solids are controlled by dilution and jetting tanks.

On one recent rig installation where a ClayJector was installed to maintain a 17 lbs./gal. mud system, the conservative estimate of savings was $425 per day!

Key to ClayJector efficiency is the DorrClone classifier, a cylinder-conical unit using centrifugal force in place of gravity. Four of these units are manifolded in a common housing with a common feed, overflow, and underflow. Any of the units can be cut out of service without opening the housing to meet variations in circulation requirements.

For more information on the ClayJector, contact our U. S. Sales Representative, Salt Water Control, Inc., 1211 Fort Worth National Bank Building, Fort Worth 2, Texas.

A Dorr-Oliver ClayJector in operation. Note simplicity of installation directly over mud tank.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U. S. A.

For more data on advertised products, use Readers' Service Cards, last page.

FASTEST . . . ABLEST HELICOPTERS—Two Sikorsky S-58s on their delivery flight to Humble Oil and Refining Co. are shown equipped with flotation gear. Main wheels are retractable. In the Gulf of Mexico area alone, versatile Sikorsky S-58s and S-55s are carrying more than 20,000 crewmen and specialists each month.

S-58—Newest, Fastest, Ablest

TWELVE PASSENGERS and baggage are routine loads for Sikorsky S-58 helicopters operated by Rotor Aids Inc. on flights offshore as pictured here. This long-established operator maintains round-the-clock commuting service with these agile helicopters to platforms on rigs or tenders. Float-equipped S-58s can carry full loads 125 miles offshore and return without refueling.

Already hard at work in the Gulf of Mexico area, new twelve-passenger Sikorsky S-58 helicopters are speeding up the progress of offshore drilling operations. The S-58 equipped with floats can fly 125 miles offshore and return without refueling. It cruises at better than 90 mph. Offering oil companies and charter operators the latest advances in the helicopter art, the S-58 is the newest and ablest offshore transport, carrying more men farther and faster than any helicopter previously available.

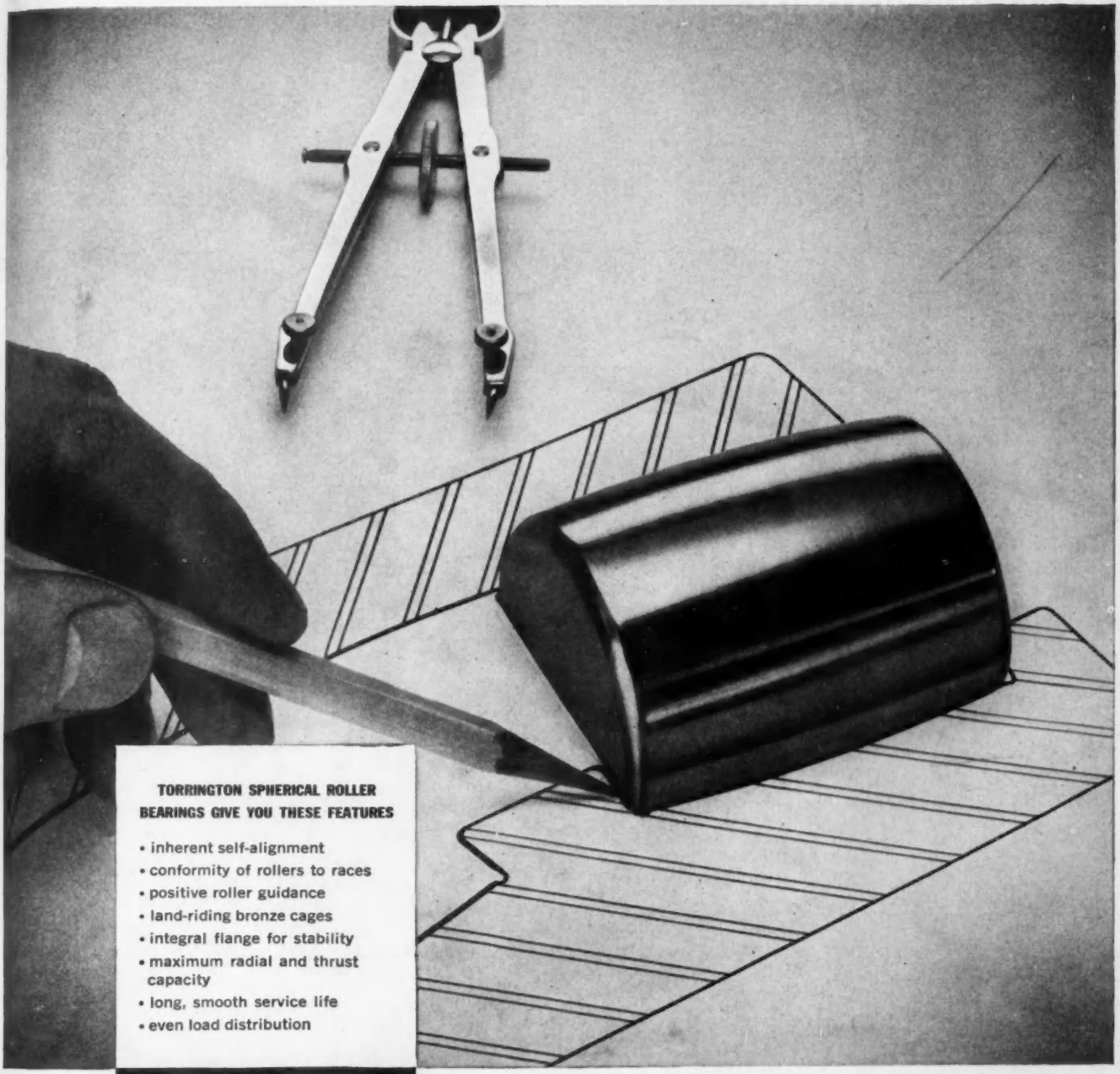
The new Sikorsky S-58 and its companion, the S-55, are the acknowledged leaders in offshore transport helicopter service. Sikorsky helicopters every day are solving more and more transportation problems in offshore oil activities, as they have in so many other activities all over the world where surface transport is difficult.

For more information on Sikorsky helicopters, telephone or write Lee S. Johnson, general manager, Sikorsky Aircraft.

SIKORSKY AIRCRAFT

BRIDGEPORT, CONNECTICUT

One of the Divisions of United Aircraft Corporation



TORRINGTON SPHERICAL ROLLER BEARINGS GIVE YOU THESE FEATURES

- inherent self-alignment
- conformity of rollers to races
- positive roller guidance
- land-riding bronze cages
- integral flange for stability
- maximum radial and thrust capacity
- long, smooth service life
- even load distribution

Mated perfectly ~ for life!

Make a point to notice the roller end and center guide flange in a Torrington Spherical Roller Bearing. The perfect mating there means a smoother, longer bearing life.

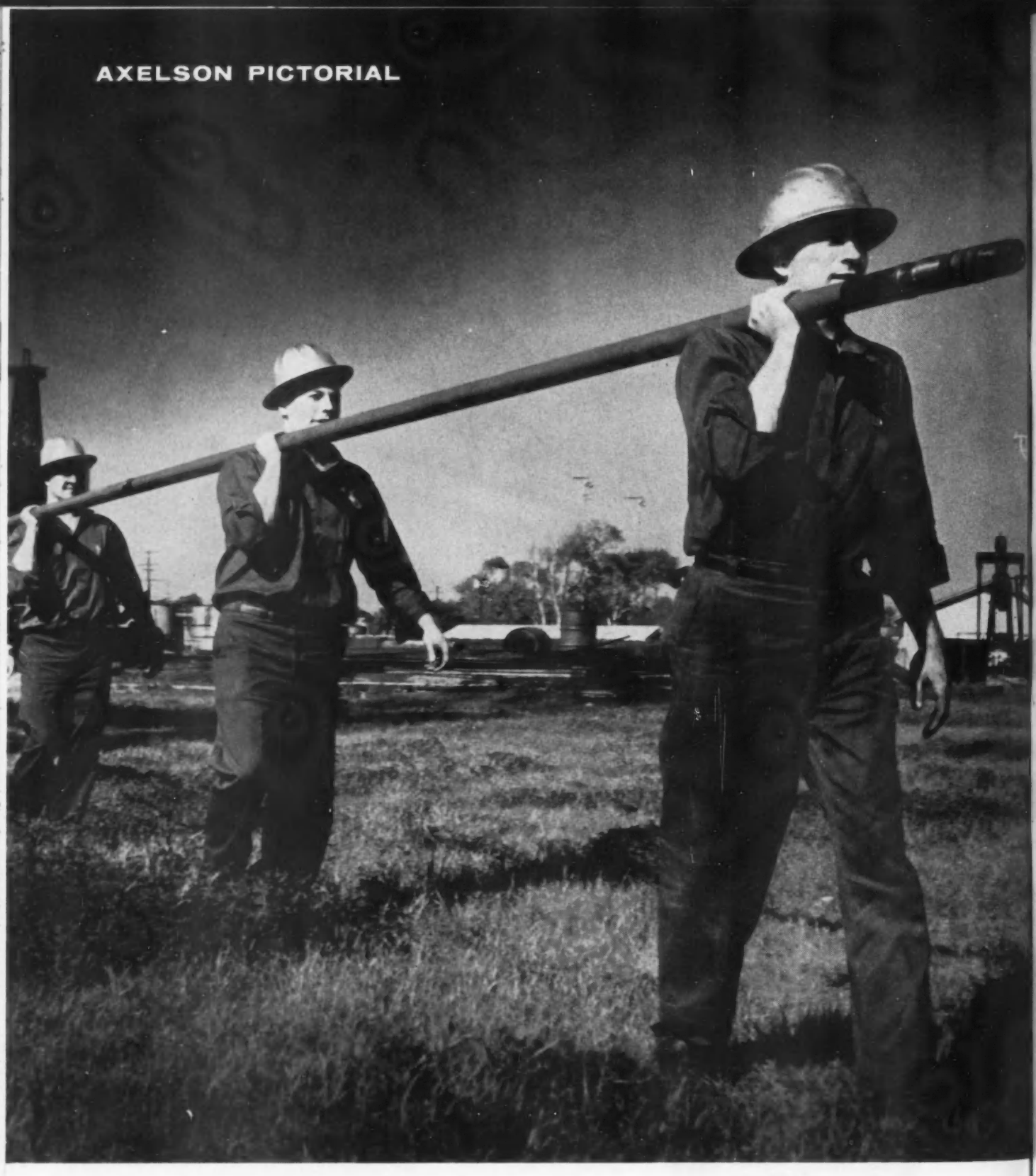
Roller end and flange surfaces alike are ground to a common spherical radius centered on the common vertex of bearing axis and roller axis. Under all load conditions, the rollers bear lightly but constantly against this flange. This guides the roller positively with minimum friction and prevents skewing. Stress concentrations leading to early failure are avoided, so the bearing will serve you many good turns longer.

This is the kind of feature Torrington builds into its bearings out of its experience with all major types serving in all kinds of equipment. Care for such details is matched only by our care in mating the *right* bearing to the *right* job. In this, your Torrington representative is an expert: call on him when you need help. *The Torrington Company*, South Bend 21, Ind.—Torrington, Conn.

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST



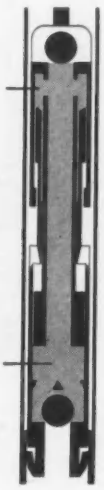
24 FEET OF PUMP is headed for the bottom of a hole, assigned to offset water encroachment by increasing gross production. This Axelson Volumax is constructed as two pumps in tandem, but lifts maximum volumes because its operation simulates two pumps in parallel. As these units reciprocate, two displacement areas simultaneously fill from the formation and transfer fluid into the tubing string.

In addition to stepping up production at the same cycle rate, the Volumax can assure maintenance of current gross production at an appreciably reduced cycle rate.

To overcome the tendency of this pump to unseat, the patented Axelson friction-ring type cup hold-down was developed. Field use of this new type of hold-down has been consistently successful.

150 to 405 MORE BBLS. PER DAY WITHOUT TUBING JOB

Secret of increased production is in filling of entire expanded annular area during upstroke.



Fluid enters here as in conventional stationary pump.

Production men report that expensive tubing jobs are no longer necessary when they want big increases in volume.

Operators in all parts of the country have found they can usually hit their required fluid rate by replacing an insert pump assembly with an Axelson Volumax.

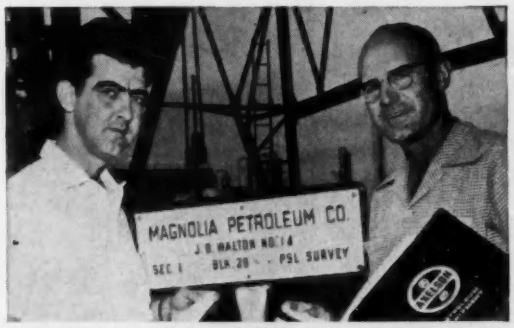
The Volumax is actually two-pumps-in-one with a patented design that allows two displacement areas to simultaneously fill from the formation with each upstroke, instead of the conventional single chamber.

The above diagram shows the extended area that is filled during the upstroke. Velocities of flow are reduced by allowing the larger of the two displacement chambers to fill directly from the standing valve. A lesser quantity of fluid is then required to pass through the restricted seal plunger and pull tube to fill the upper chamber.

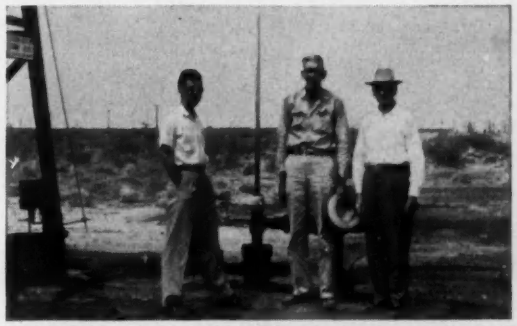
On the down-stroke, fluid is compressed, opening the traveling valve and transferring fluid into the tubing.

Ample fluid passages, plus the novel stationary-traveling construction, expedite the entry of fluid from the formation, thereby assuring the maximum fill of the pump during the upstroke.

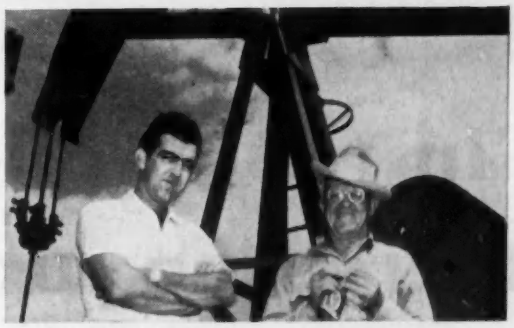
With any given stroke, a Volumax installed in 2½″ tubing allows a 27% displacement increase over a tubing pump. Three applications are pictured at right.



WOULDN'T PUMP DOWN—When the water flood injection rate was increased in Magnolia's Kermit Field, Winkler Co., Texas, the 2¼″ tubing liner pump could no longer pump down the well. A VOLUMAX 2½″ (2″ x 1¼″) x 12′ x 24′ pump was installed, production increased from 360 to 510 bbls/day. Pictured are Axelson's H. E. Summers and Magnolia's C. W. McDonald, assistant production foreman.



HALF OIL, HALF WATER—Richardson Oil's J. F. Hathaway No. 15 in Ward County, Texas, was making 299 bbls. of oil and 302 bbls. of water with a 2¼″ tubing pump before a VOLUMAX 2½″ (2″ x 1¼″) x 12′ x 24′ pump was installed and boosted production to 463 bbls. of oil and 408 bbls. of water/day, with no change in speed or length. Axelson's Summers is with Richardson's B. P. Mathena and J. W. White.



OUTPUT DOUBLED—Axelson service and the VOLUMAX pump again teamed up at Tidewater Oil Company's W. D. Johnson No. 6, also in Ward County, Texas. A 2¼″ tubing pump was lifting 430 bbls. total fluid/day with a 54″ stroke; this was increased to 835 bbls./day with a VOLUMAX 2½″ (2″ x 1¼″) pump and a 74″ stroke. Summers is with O. S. Jones, Sr., a 30-year Tidewater pumper.

AXELSON PUMPS AND RODS

Axelson Manufacturing Company
Division of U.S. Industries, Inc.
6160 South Boyle Avenue
Los Angeles 58, California

For quality production equipment and service:
Axelson stores throughout California.
Jones and Laughlin Supply stores in Mid-Continent, Rocky Mountains, and Canada.
Great Northern Tool and Supply Company in Rocky Mountains.
Dominion Oilfield Supply Company in Canada.
Axelson Dealers and Distributors also located in Mexico, Argentina, Bolivia, Brazil, Colombia, Peru, Venezuela, and Trinidad, B.W.I.

One of the Macks operated by H. L. Choate Trucking Company—an oil-field hauler from Alice, Texas. President Choate says...

"In rough oil-field operations... there's no substitute for a MACK"

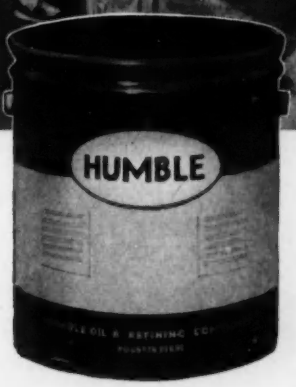
"Thirty years in the oil fields have taught me that Macks are the only real truck buy. Their thrifty, steady work habits quickly make up for their higher initial price... they pile up year after year of money-making service long after so-called 'bargain' trucks are on the scrap heap. I've made my last experiment with buying cheaper trucks. For my money, there's no substitute for a Mack."

That's the way Mr. Choate, president of Choate Trucking, feels about Macks. And his oil-field operation certainly puts trucks to the test. Loads vary from 25,000 to 135,000 pounds. Hauling is often through swamps, heavy sand, gumbo mud, and over mountainous terrain. Yet Choate's Macks average 5 to 8 mpg of diesel fuel... running up 50,000 miles a year and plenty of winch time... with a minimum of down time.

Here's just one more example showing why it pays to operate the best. Your local Mack representative will gladly show you other on-the-job reports proving the same point. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

MACK
first name for
TRUCKS

5152



Use **Humble's Thredkote 701** for maximum tool joint life

Thredkote 701 is a top-quality thread lubricant containing 60% pure metallic zinc. When the tool joint is madeup tight, this zinc is deposited on the threads in a thin film. As the string is run, this zinc film effectively guards against metal-to-metal contact and prevents galling.

Thredkote 701 gives the tool joint threads superior lubrication, so the joints will makeup easy and tight. It seals against high pressures, yet permits ready break-out.

Be sure to give new tool joint threads a careful and complete coat of Thredkote 701 for the first four or five trips that they make. New tool joints need this extra lubrication and protection because they resist makeup more than old ones, and their threads are more likely to gall.

Thredkote 701 is one of a complete line of Humble thread compounds. There's one for almost every type of threaded connection. For more information on Thredkote, call your nearest Humble wholesale plant, or write or phone:

HUMBLE OIL & REFINING COMPANY

HUMBLE

Technical Service
Sales Department
Humble Oil & Refining Company
P. O. Box 2180
Houston 1, Texas

For more data on advertised products, use Readers' Service Cards, last page.

CATERPILLAR

Pushing through the world's longest pipeline

With 35 Caterpillar-built units in its spread, Majestic Contractors, Ltd., is laying 34-inch at a pace usually reserved for smaller pipe

Seven Cat No. 583 Pipelayers are helping Majestic Contractors, Ltd., lay 1½ miles of 34-inch pipe a day on the Trans-Canada pipeline.

No. 12 Motor Grader and two D7s are used on backfilling operations. The spread includes 35 pieces of Caterpillar equipment—engines, pipelayers, tractors and motor graders.

A Cat D339 Diesel powers this Cleveland ditcher in Saskatchewan. There are nine rugged, heavy-duty Caterpillar Engines at work in the spread.

When finished, the Trans-Canada pipeline will be the longest in the world. It will slash 2,500 miles across Canada, bringing Alberta gas as far east as Montreal.

Majestic Contractors, Ltd., of Edmonton, Alberta, is laying a 100-mile section of the pipe from Burstall to Leinan, Saskatchewan. It is putting the 34-inch pipe into the ground at an average rate of 8,700 feet per day. This equals the rate that smaller big-inch pipe is being laid elsewhere in the industry. In one record 10-hour working day, Majestic welded 305 joints of 40-foot-length pipe.

Spread No. 1, which is setting this pace, is practically all Caterpillar. It includes seven new CAT* No. 583 Pipelayers, the highest capacity machines in the industry; five MD7 Pipelayers; seven D7s; three D6s; two D4s; one D2, and a No. 12 Motor Grader. And Majestic is relying on nine rugged, heavy-duty Caterpillar Engines to power other equipment. There are seven D318s, one on a Cleveland backfiller and six on Bucyrus Erie shovels. In addition, there are two D339 Diesels on Cleveland ditchers.

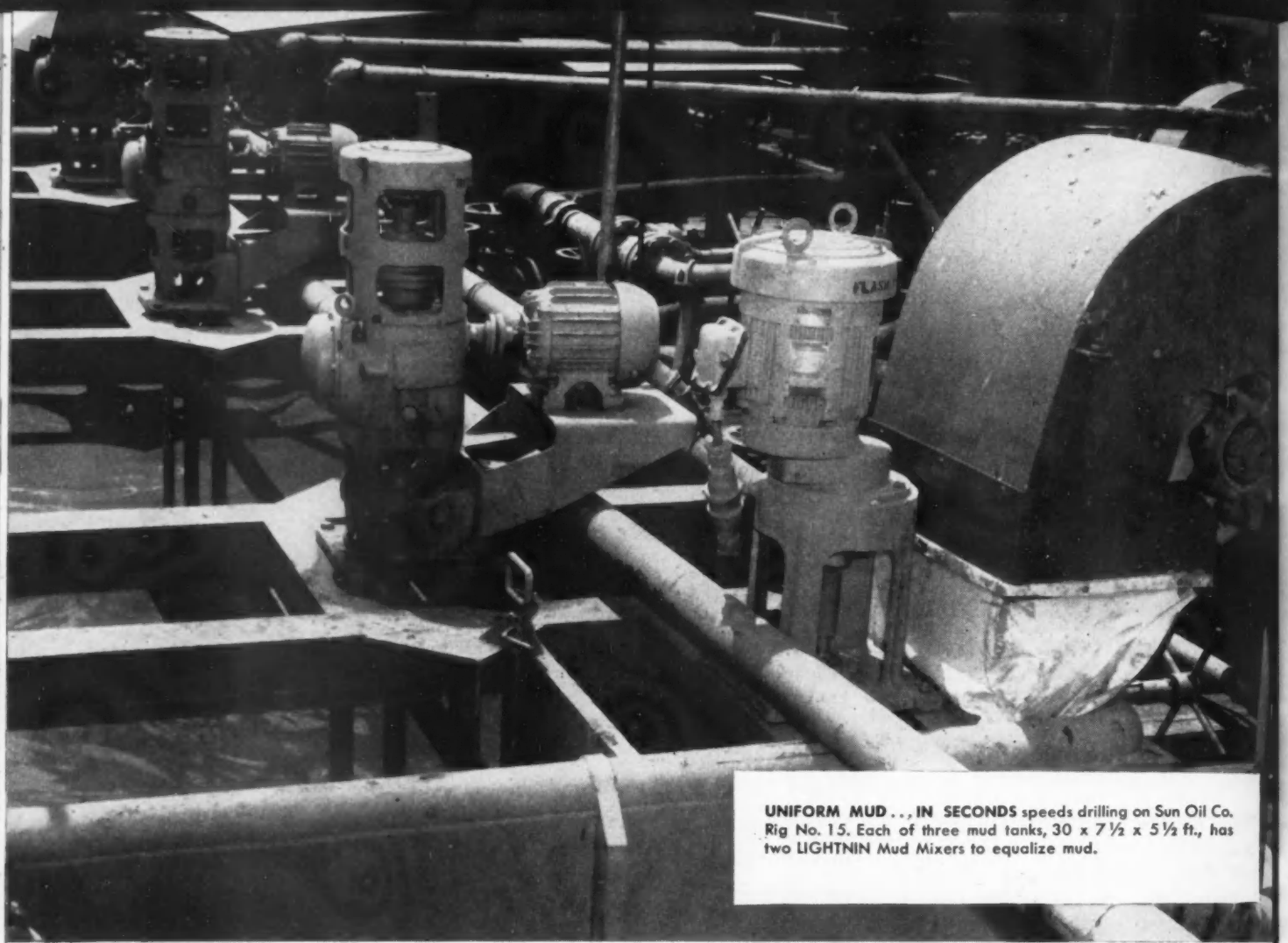
Right-of-way is 65 feet. The ditch measures 52 inches at the bottom and 90 inches at the top. This is widened to 8 feet, 4 inches in sandy terrain. Here the No. 583 Pipelayers stay 10 to 12 feet from the 6-foot-deep ditch to lower the 150-pound-per-foot, 34-inch pipe. All pipe is being cradled in immediately following the doping and wrapping operations.

You can look for the production record on this job to become increasingly common in the industry as new No. 583s join more and more spreads. This is the highest capacity pipelayer in history, and it is establishing a new standard for a day's work. This efficient pipelayer can lift 130,000 lb. and its engine delivers 191 HP. And because of its well-balanced design, it is as safe as it is fast.

In the complete line of Caterpillar* oilfield machines and engines, there is a unit to fit every need. So call your Caterpillar Dealer soon. He will demonstrate any of his high-production machines on your job—at your convenience.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U. S. A.

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



UNIFORM MUD . . , IN SECONDS speeds drilling on Sun Oil Co. Rig No. 15. Each of three mud tanks, 30 x 7½ x 5½ ft., has two LIGHTNIN Mud Mixers to equalize mud.

How Sun gets **uniform mud . . . fast** *on big new diesel rig*

You're looking at one of the speediest—and safest—mud conditioning systems ever put into operation on a big rig.

See how every part of this mud system, on Sun Oil Co.'s new diesel-electric Rig 15, makes for uniform mud and rapid drilling:

1. The belt conveyor, at right, dumps bulk mud into an open-bottom mixing well equipped with a LIGHTNIN Flash Mixer. High-speed propellers break lumps and disperse mud and other ingredients instantly—as fast as they are fed in.

2. In each tank, two LIGHTNIN Mud Mixers drive mud throughout the tank in a strong, interchanging flow. All the mud is in motion at once. Every gallon of mud is at correct weight and viscosity—ready for instant use. Mud doesn't settle out, so less mud is used.

3. When weight or gel material is added, mud consistency starts to change at once. Any addition is equalized throughout the tank quickly.

How to get instant control

You can get mud control like this with LIGHTNIN Mixers on your rigs. Keep mud evenly mixed with practically no attention. Increase mud weight and viscosity by the exact amount you want—in seconds.

You take no risk with LIGHTNINs. Results are guaranteed, unconditionally.

Not only do LIGHTNINs help you drill faster—they look good on the cost side, too. Maintenance is much less than with other equipment. *And you need no auxiliary mud pump.*

Get facts firsthand

See for yourself how LIGHTNIN Mixers can give you *better* mud control, for *less* money. Just ask your LIGHTNIN sales engineer to arrange a visit to a rig in your area where LIGHTNINs are at work. You'll find his name in Composite Catalog. Give him a call today.

SEND FOR this free 6-minute picture story. It shows how you can get instant mud control and cut costs, too, with LIGHTNIN Mixers. Just drop us a postal, asking for Bulletin B-502.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 197-f Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

"Use **wire rope?** Get this helpful **recommendations book!"**

"Roebling Wire Rope Recommendations and Catalog" is designed to simplify the selection and ordering of the right wire rope for specific applications—whatever they may be.

The best wire rope for top performance on any job shows up at a moment's notice . . . making the right choice is easy as flipping the tabbed pages of this easy-to-follow, 56-page book. Besides, there's a simple, foolproof, coded ordering system, which identifies the desired size, grade and construction.

May we send you your copy? Mailing the coupon will bring it to you at once. And should the catalog prompt any question on which you'd like further information, field men from your nearest Roebling office or distributor will, of course, assist you . . . or write Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

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Please send me my copy of "Roebling Wire Rope Recommendations and Catalog."

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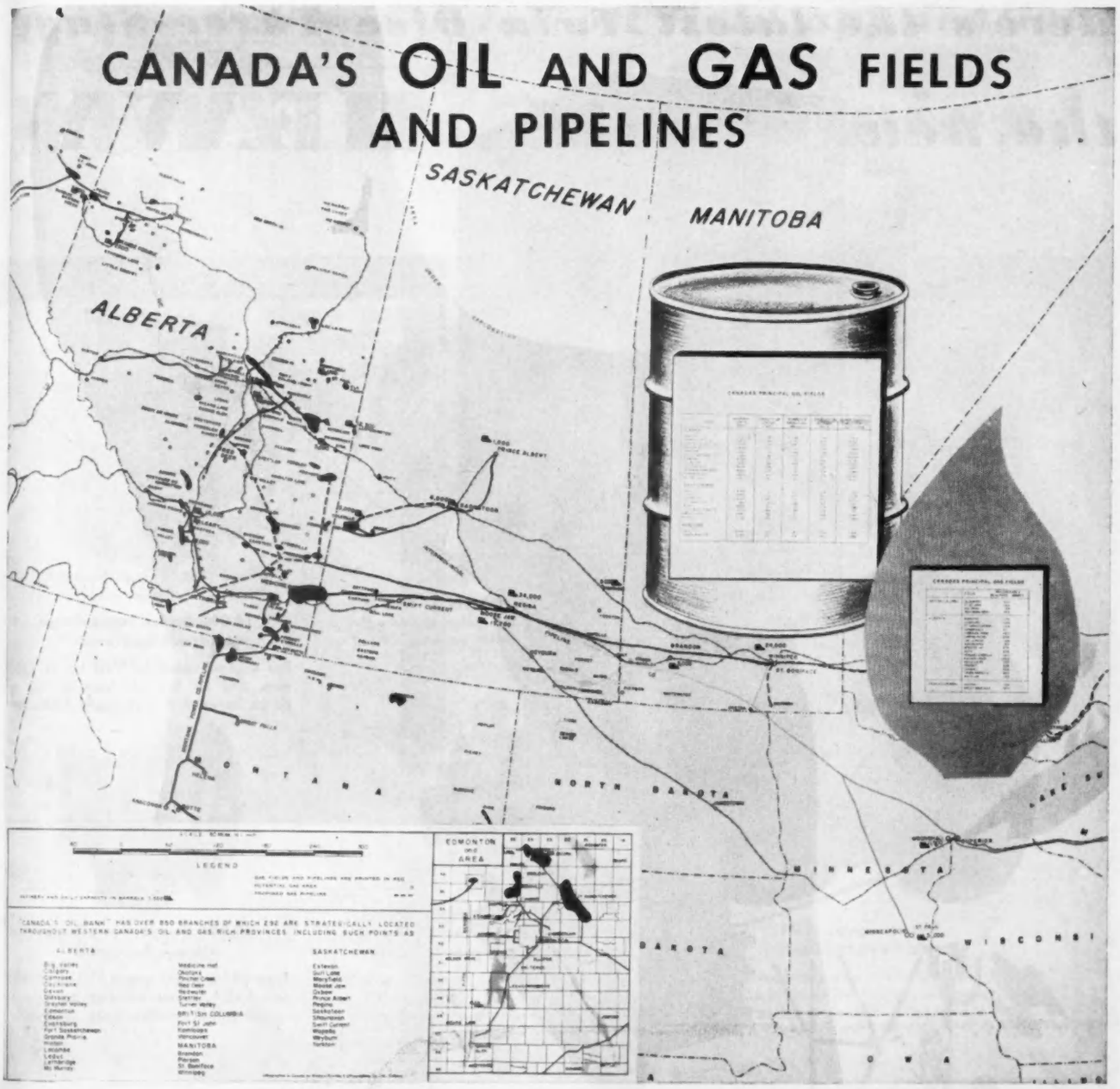
ROEBLING

Branch Offices in Principal Cities · Subsidiary of The Colorado Fuel and Iron Corporation

For more data on advertised products, use Readers' Service Cards, last page.

MIXCO fluid mixing specialists In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

An oilman belongs at every table Pipeliners—in fact, *all* oilmen—help set the family table. Oil-based insecticides, weed killers, fertilizers, livestock dips and animal medicines help bring better fruits, vegetables and meats to market. You cook them with natural gas or electricity that oil fuels probably generated. Sometimes people who know little about oil talk loudly against our industry. That's when we oilmen should point out that at home, as elsewhere, oil serves people well. **SHELL OIL COMPANY**



get this map of buried treasure!

Prepared by the Oil and Gas Department of The Royal Bank of Canada—Canada's "Oil Bank"—this new map measures 43" x 23". Scaled 60 miles to the inch and lithographed in three colors, it shows Canada's principal oil fields, pipelines, potential oil areas, proposed oil pipelines, refineries and daily capacity in barrels. For a copy of this free map and a list of the Royal Bank's current *"Oil and Gas Bulletins"* write to: The Royal Bank of Canada, Oil and Gas Department, 409 8th Avenue West, Calgary, Alta., Canada. These *"Oil and Gas Bulletins"* are revised by the bank as necessary and cover statistics, regulations, tariffs, oil and gas financing and kindred subjects. They are up-to-date and of practical value to anyone seriously interested in Canada's oil and gas industry.

We do not provide information on oil securities.

THE ROYAL BANK OF CANADA

Canada's Oil Bank

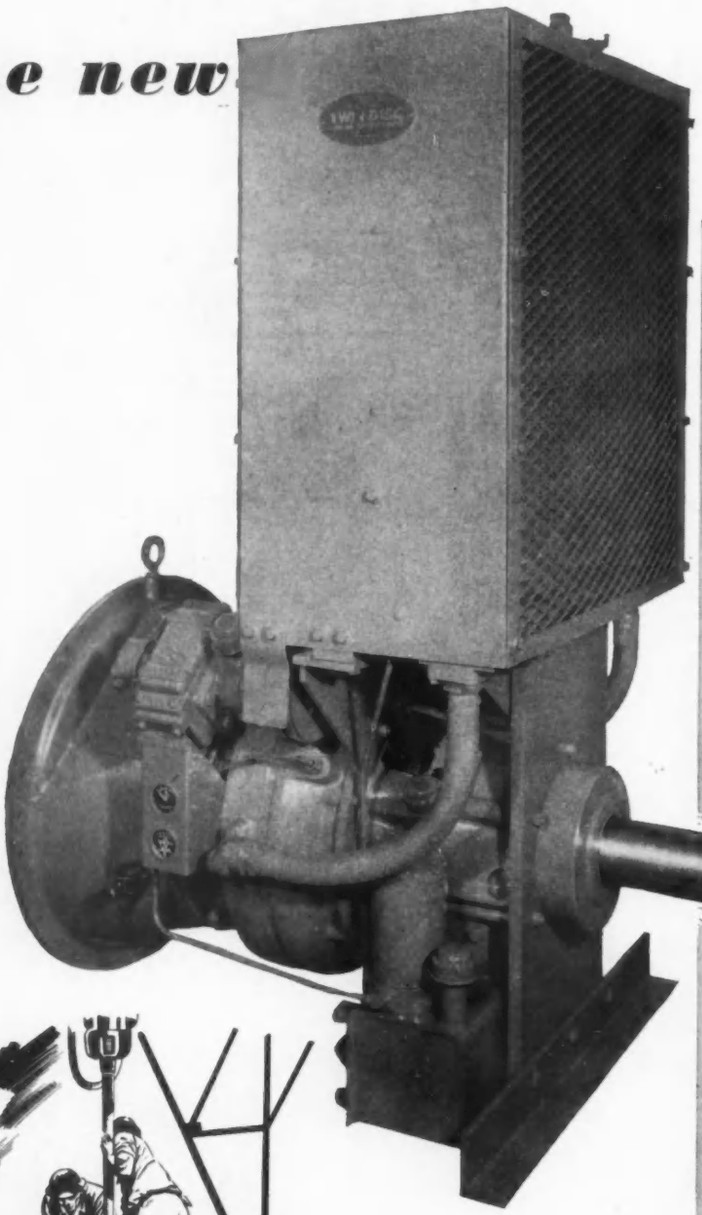
New York Agency—68 William Street, New York 5, N. Y.
Head Office—Montreal

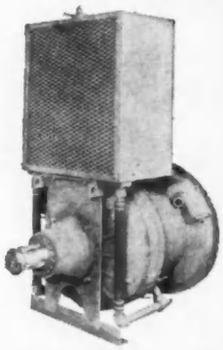
Assets exceed 3½ billion dollars

Over 880 branches in Canada, the West Indies, Central and South America. Offices in New York, London and Paris.

Here's the latest Twin Disc Three-Stage

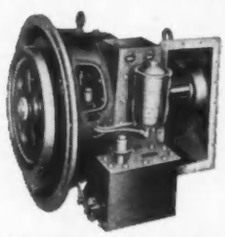
the new HEAVY-





16,000 Series Three-Stage Torque Converter

For engines rated to 1000 hp at 1500 rpm. SAE 00 flywheel housing size or clutch between flywheel and converter.



10,000 Series Three-Stage Torque Converter

From 60 hp at 700 rpm to 335 hp at 2400 rpm. SAE 1 flywheel housing size. Various input-output combinations available.

Further extending its line of three-stage torque converters, Twin Disc Clutch Company now offers the petroleum industry an additional version of its popular 11,500 Series Three-Stage Models.

Designated the Heavy-Duty 11,500 Series Torque Converter (a Standard-Duty version will be continued), the new units have a maximum rating of 586 hp at 2200 rpm. Maximum input torque is 1400 pound-feet. Impellers are available for specific torque ratings of 340, 390, 450 and 540 pound-feet.

Current production units include the Model CF, which provides a clutch at the flywheel, and the Model F, which is connected to the flywheel with a driving ring. Both types are designed for SAE No. 0 flywheel housings.

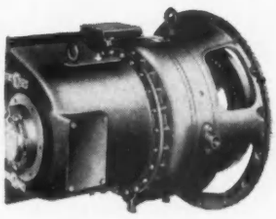
A Twin Disc C-3 Rear End, with the output shaft supported by two heavy-duty roller bearings, is available with either model, permitting maximum output sidepull. Available as optional equipment is a radiator integrally supported as a part of the torque converter.

With the addition of the Heavy-Duty 11,500 Series units, Twin Disc now offers the petroleum industry a line of three-stage torque converters with ideal matching characteristics for engines rated from 60 to 1000 hp and from 700 to 2400 rpm.

The complete line of three-stage torque converters includes five dis-

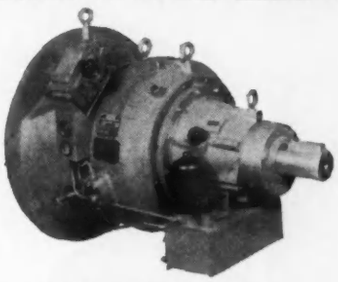
Torque Converter for oil field applications

DUTY 11,500 Series!



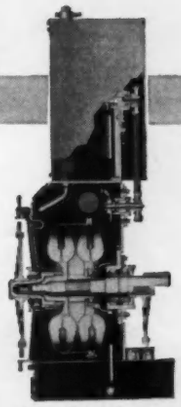
Standard-Duty 11,500 Series Three-Stage Torque Converter

From 60 hp at 700 rpm to 425 hp at 2200 rpm. SAE 0 or 1 flywheel housing sizes. Various input-output combinations.



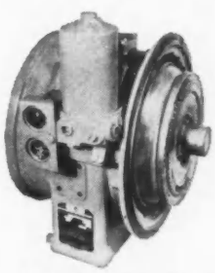
13,800 Series Three-Stage Torque Converter

To 600 hp at 1800 rpm. SAE 00 or 0 flywheel housing sizes. Spider drive or clutch between flywheel and converter.



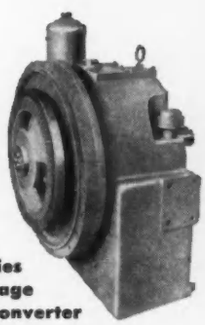
Disconnecting Fluid Power Take-Off

Model 27 for engines to 850 hp at 1525 rpm. Model 21 for engines to 580 hp at 1900 rpm. Radiator and fan standard.



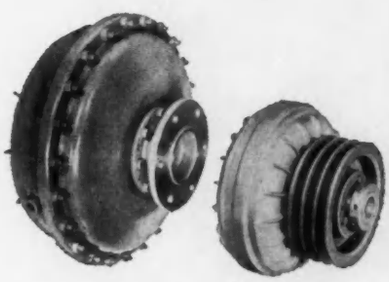
1300 Series Single-Stage Torque Converter

From 30 hp at 1450 rpm to 212 hp at 3200 rpm. SAE 2 flywheel housing size. Output adaptable to SP-111 PTO.



1500 Series Single-Stage Torque Converter

From 30 hp at 1100 rpm to 207 hp at 2500 rpm. With or without clutch. Various input-output combinations available.



Fluid Couplings and HYDRO-SHEAVE® Drives

Fluid couplings from 7.4 to 27 inches, to 850 hp. HYDRO-SHEAVE Drives fractional to 50 hp at nominal motor speeds.

tinct sizes: the 10,000 Series, Standard-Duty 11,500 Series and Heavy-Duty 11,500 Series, 13,800 Series and the 16,000 Series. The line offers 33 specific torque ratings and input and output arrangements to meet virtually every industrial requirement.

These three-stage torque converters have long proved themselves on such applications as drilling rigs, mud pumps and many others. They offer such advantages as multiplying engine input torque (up to 6:1) exactly as required by load . . . cushioning out destructive shocks and vibrations . . . minimizing maintenance and downtime . . . and *producing more work on a hp-cost basis.*

Twin Disc also offers single-stage torque converters rated from 30 to 212 hp at speeds up to 3200 rpm for those installations where milder torque multiplication is desirable.

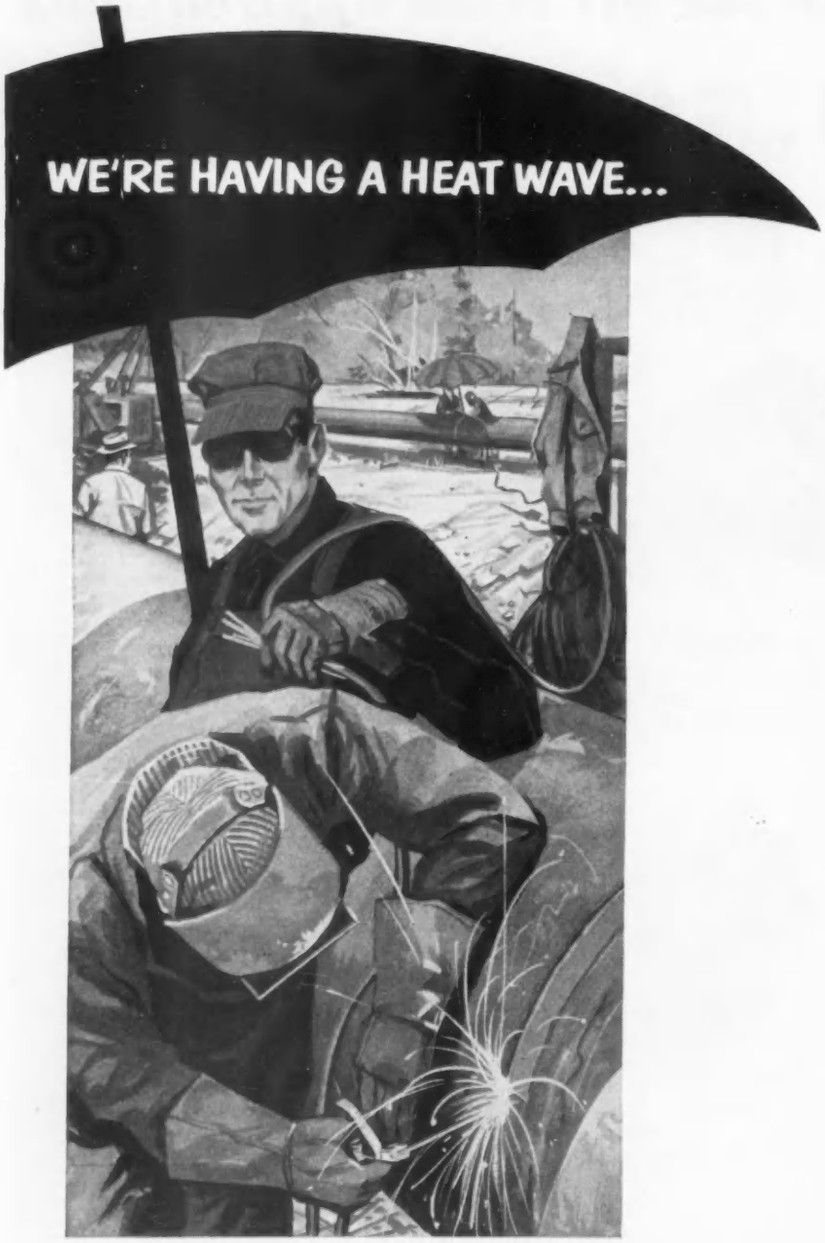
Twin Disc Fluid Power Take-Offs and Fluid Couplings are available to 850 hp, and are widely used throughout the oil fields where torque multiplication is not required but where the many operating advantages of fluid drive are desirable.

Twin Disc Clutch Company, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives



... but neither summer sun nor winter snow stops Transco's search for new and profitable markets for natural gas. During 1956, Transco delivered record quantities of gas to heat-hungry markets. This year, look to Transco for a real heat wave ... a wave to increase natural gas movement—to bring heat for warmth and fuel for power to our best potential markets ... the places where the most people are.

HELPING TO EXPAND THE MARKETS
FOR TEXAS-LOUISIANA NATURAL GAS

TRANSCONTINENTAL GAS PIPE LINE CORPORATION

Letters

Sir:

In the face of mounting costs in finding oil and high costs of deep-well and offshore drilling and production, many people are recalling the flush production days of Tampico and Veracruz. Independents in Southwest Texas have no doubts about oil possibilities just across the Rio Grande. In fact they visualize a whole trend of fields in the Monterrey-Laredo-Matamoros-Tampico quadrangle. There should be many good shallow fields in the area, extensions of trends are apparent in Southwest Texas.

And it may surprise oil men to learn that public opinion in Mexico is shifting in their favor. A short four years ago much was said in the press about "entreguismo"—the surrender of national wealth to foreign interests. Venezuelan prosperity and progress under a more enlightened program of oil development with company responsibility for some of the socio-economic side effects of oil activity may have influenced government officials. Certainly the lack of capital to do extensive wildcatting and drilling has kept Petroleos Mexicanos far behind domestic consumption, so that oil is the biggest import item in Mexico's budget.

Mexico needs a thousand independent oil men, with all the dollars they can rake up. Public opinion in Mexico is coming around to that realization. Mexico needs much better grades of gasoline for the thousands of new American automobiles with high-compression engines. Mexico needs a thousand more filling stations, but here again the money is lacking to build them. It wouldn't surprise me if three years from now high-test name-brand gasoline were to be marketed in hundreds of new filling stations in Mexico. And American risk capital and teams, under some arrangement, are again working in Mexico. It's the will of the people.

Robert N. Jones
Engineer

Be Sure To Check
WORLD OIL'S
Classified Section

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ECONOMICAL
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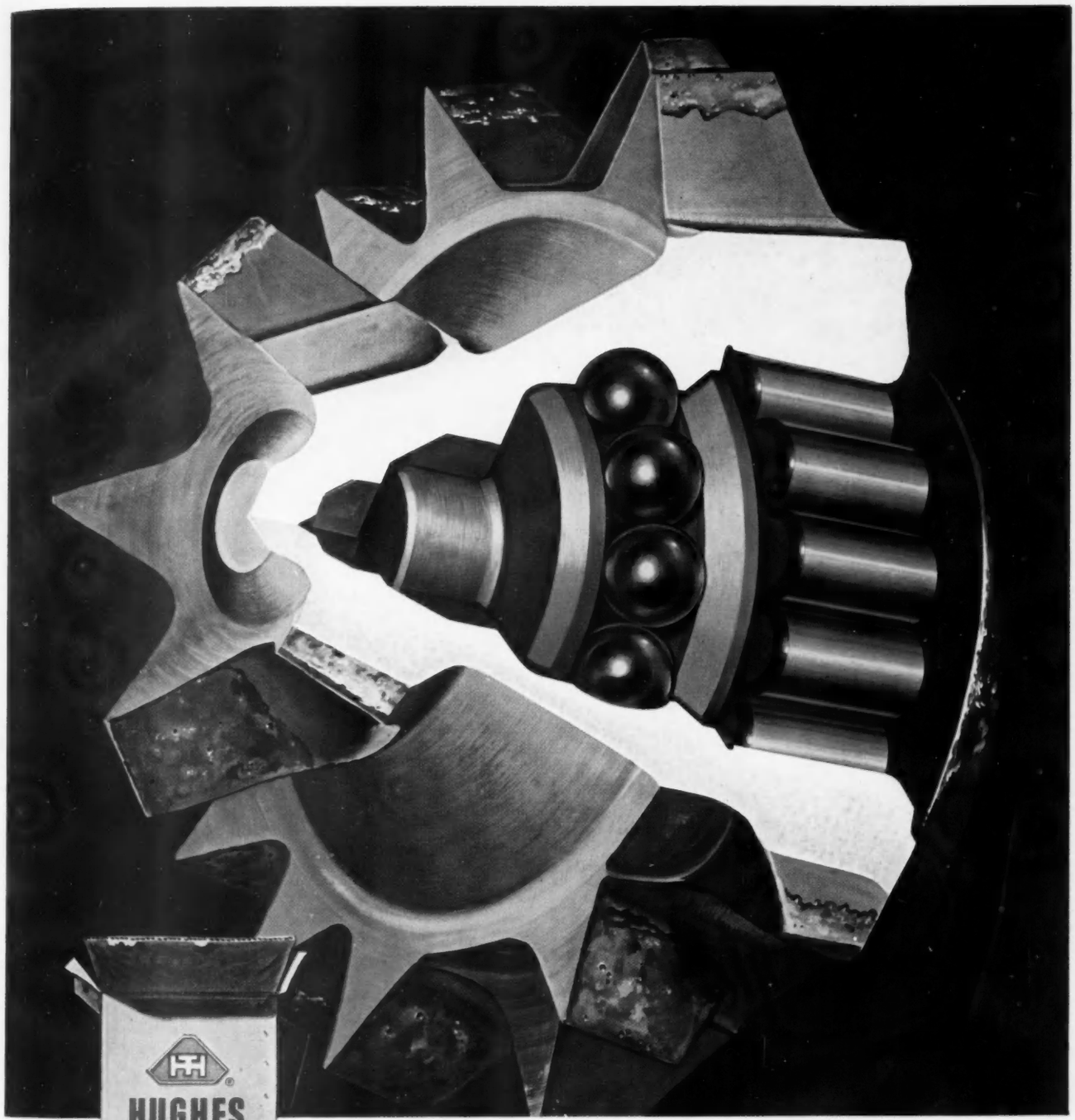
You can buy or sell anything from a used truck to a drilling rig through a Classified Ad in World Oil.

For more data on advertised products, use Readers' Service Cards, last page.

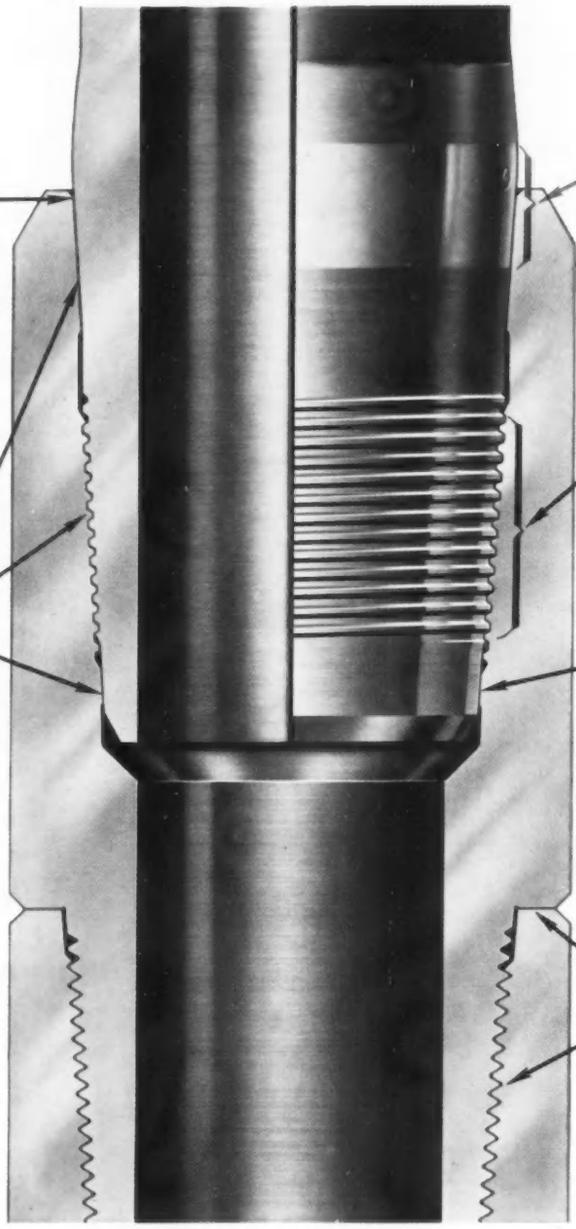


A STOUT HEART... for Longer Life

One of the big reasons you are today getting increased footage with Hughes rock bits is the improved quality of the bearings. The design and metallurgy of Hughes bearings have never been permitted to remain static.

Teams of product, research, metallurgical and field engineers are constantly evaluating designs and materials to determine the combinations that will deliver the best results. Aiding materially in this evaluation is the physical examination of the bearings of thousands of selected dull bits sent to the Research Laboratory each year from the various fields with their performance records.

The work of these engineers, backed by Hughes' nearly 50 years experience with rock bits, is being reflected in the continued improvement in bit performance.



Steep taper permits thick section at point of last contact between pipe and tool joint where bending loads in pipe are greatest.

This critical area of the pipe is **cold-rolled** at the mill for greater strength, using equipment and techniques developed by Hughes engineers.

Engaged thread strength in shear is greater than two times the strength of the drill pipe.

All mating surfaces — the outer seal, pipe threads, and inner seal — are on the same taper. This provides uniformity of fit on initial and replacement installations.

Nose seal is on taper to assure uniformity of fit and positive seal against leakage, on both original or replacement installations. This prevents corrosive fluids attacking threads.

The three points of engagement of the "Seal-Grip" joint provide a FRICTION GRIP stronger than the torsional strength of the pipe.

Copperplating of threads and shoulders of Hughes tool joints protects against scoring and galling.

Hughes offers improved SEAL GRIP assembly

The process and equipment developed by Hughes for cold rolling the large land area of the drill pipe at the pipe mill produce a superior "Seal Grip" assembly unequalled in strength and dependability.

In laboratory fatigue tests—*where pipe is run to destruction*—we have not been able to induce a single failure in the cold-rolled area of the pipe. This added feature plus superior design makes HUGHES "Seal Grip" today's best buy in replaceable tool joints.

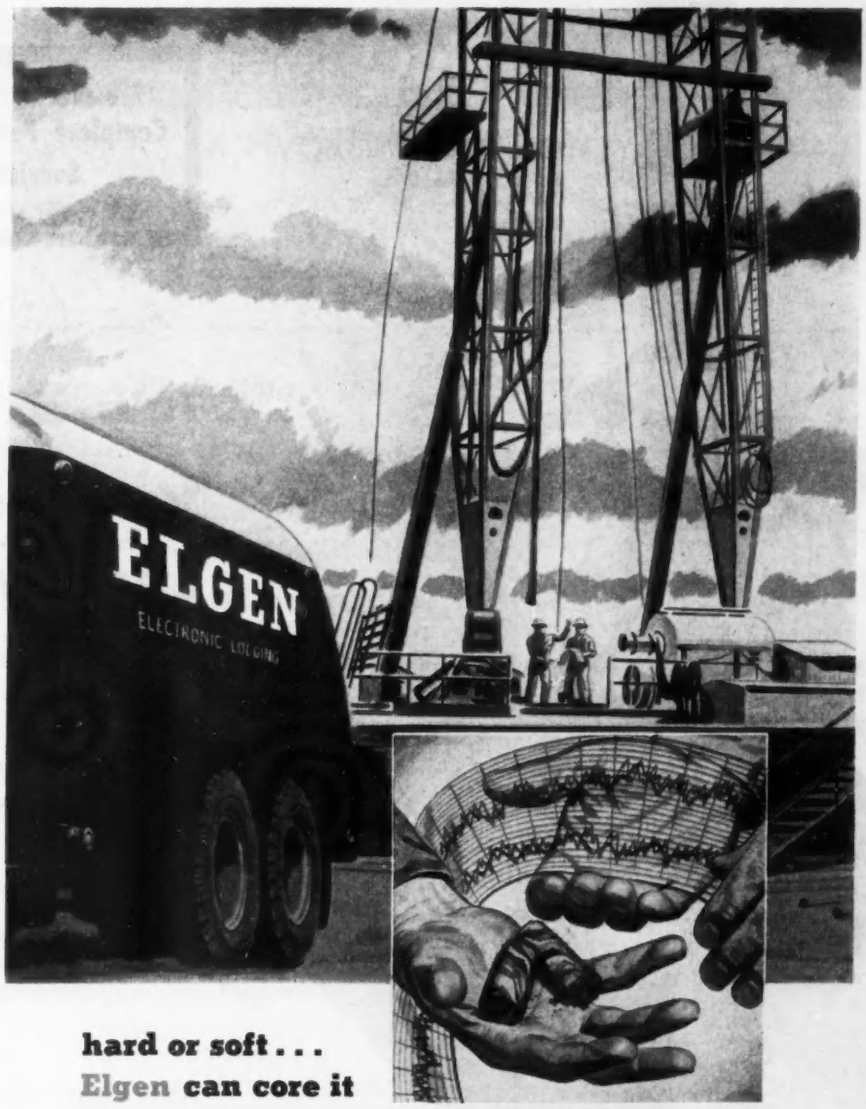
HUGHES TOOL COMPANY

Developers of "Flash-Weld," "Seal Grip" and Counterbore Weld Tool Joints

WHO'S MEETING WHERE

JUNE 3- 5	PEPA, Annual Conference, Herring Hotel, Amarillo, Texas
4- 6	Appalachian Underground Short Course, West Virginia University, Morgantown, Penn.
5- 7	Pennsylvania Grade Crude Oil Association, 34th Annual Meeting, Penn-Sheraton Hotel, Pittsburgh.
9-14	API Division of Production, Midyear Committee Conference, Muehlbach Hotel, Kansas City, Mo.
10-12	Interstate Oil Compact Commission, Midyear Meeting, Canyon Hotel, Yellowstone National Park.
12-14	API Division of Finance and Accounting, Midyear Meeting, French Lick-Sheraton Hotel, French Lick, Ind.
20-22	Intermountain Association of Petroleum Geologists, Eighth Annual Field Conference. Begins at Vernal, Utah, and Ends at Soldier Summit, Utah.
23-27	Canadian Gas Association Meeting, Jasper Park Lodge, Jasper, Alberta.
SEPT. 5- 7	New Mexico Geological Society, Eighth Annual Field Conference, Durango-Silverton-Ouray Area of Southwestern Colorado.
11-13	National Petroleum Association, 55th Annual Meeting, Atlantic City, N.J., Traymore Hotel.
26-27	Mid-Continent Oil & Gas Association, Louisiana-Arkansas Division, Annual Membership Meeting, New Orleans, Roosevelt Hotel.
OCT. 1- 2	Texas Mid-Continent Oil & Gas Association, 38th Annual Meeting, Texas Hotal, Fort Worth.
1- 4	National Association of Corrosion Engineers, South Central Region, Municipal Auditorium, Oklahoma City.
5- 8	National Association of Corrosion Engineers, Northeast Region, Hotel Somerset, Boston.
6- 9	AIME, Petroleum Branch, 32nd Annual Fall Meeting, Adoo Adolphus, Baker & Statler-Hilton Hotels, Dallas.
7- 9	American Gas Association, Annual Convention, Kiel Auditorium, St. Louis.
13-15	American Association of Oil Well Drilling Contractors, 17th Annual Meeting, Mayo Hotel, Tulsa.
27-29	Independent Petroleum Association of America, Annual Membership Meeting, Statler-Hilton Hotel, Dallas.
31- Nov. 1	AAPG Mid-Continent Regional Meeting, Cimarron Ballroom, Tulsa.
NOV. 6- 8	Gulf Coast Association of Geological Societies, 7th Annual Convention, Roosevelt Hotel, New Orleans.
11-14	API 37th Annual Meeting, Conrad Hilton Hotel & Palmer House, Chicago.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.



hard or soft . . .
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Elgen controlled-depth cores give a closer look at production possibilities.

Elgen's side wall core services are the finest in the field. 1 to 30 zone selections in one trip . . . cores large enough for accurate analysis. Gun loading simplicity eliminates bulky field equipment, adds to speed of operation. Automatic gauges assure knowledge of tool operation. Exclusive circuit design and maximum safety devices are featured.

Remember — you'll get FASTER, BETTER, SAFER coring results with Elgen . . . and at less cost.

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Complete Perforating Service

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LANE-WELLS SWING JET

You get Big Gun Effectiveness with a Small Diameter Gun

You get Lane-Wells first-in-perforating experience

Yes, Lane-Wells Swing Jet travels through 1½ or 2 inch I.D. tubing and swings open below tubing to give you Big Gun Effectiveness with deeper penetration—even under pressure.

AND since Lane-Wells has been perforating longer than anyone else in the business, you can rest assured they'll do your job right. So for your thru-tubing perforating, ask for LANE-WELLS Swing Jet. And for perforating under any conditions, you can count on Lane-Wells Complete Perforating Service. There's always a Lane-Wells gun to do your job RIGHT—and the experience to go with it. Swing Jet is ONE in the selection of Lane-Wells guns. Call your nearby Lane-Wells man about the COMPLETE Perforating Service.

Tomorrow's Tools-Today!

LANE-WELLS COMPANY

FOR INFORMATION WRITE:
P. O. BOX 1664, HOUSTON 1, TEXAS

LANE-WELLS CANADIAN CO. IN CANADA
PETRO-TECH SERVICE C.A. IN VENEZUELA

Looking Ahead . . .

Better Crude Prices May Halt Drilling Drop . . . The present improved prices of crude oil are expected to help reverse the current decline in U. S. drilling. The drop in drilling has been caused by several factors. Among them are the channeling of multi-millions of dollars into Venezuelan concessions in 1956 and 1957, the siphoning off of more millions by costly U. S. offshore operations, the present high interest rates on loan capital, and inclement spring weather and floods.

Labor Costs Up 6 Percent . . . Oil companies generally will pay out for the last 8 or 9 months of this year 5 or 6 percent higher salaries and wages. Increases in this range became general for non-union employes and were expected to be accepted by union workers. Other benefits also have been liberalized. New rules of some companies call for eight holidays per year and annual vacations of four weeks after 20 years of service.

No New Natural Gas Law This Year . . . The natural gas bill is essentially dead insofar as the current session of Congress is concerned. Northern distributors are sending lawyers to protest any proposed relaxation of controls by Congress. The bill is bogged down in House committee, with little chance of any action in the House, much less the Senate, before adjournment.

Better Supply of Tubular Goods Promised . . . Oil operators can expect a somewhat brighter picture regarding the supply of tubing, both carbon steel and alloy. Smaller tubular goods manufacturers are tending to specialize in tubing, even down to one-half inch diameter. Tubular goods manufacturers have largely discontinued the practice of pricing tubing on a tonnage basis like bigger pipe, one of the main causes of the generally chronic short supply of tubing.

U. S. East of Rockies to Import 12.9% of Needed Crude . . . Crude oil imports into the U. S. in the latter half of 1957 are scheduled by importers at 1,261,000 barrels daily. Excluding Pacific Coast imports, which supply a deficit of West Coast crude requirements, the U. S. will import 943,000 barrels a day. Of this volume, 59,000 a day will be from Canada, 571,000 from Latin America and 313,000 daily from the Middle East. Total 1957 demand for crude in the U. S. is estimated at 8,200,000 barrels a day, of which 7 million is east of the Rockies. The imports east of the Rockies would supply 12.9 percent of the crude demand east of the Rockies.

More Exploration Indicated in Louisiana . . . With some 100 geophysical crews working in southern Louisiana and offshore, an extended exploration program is indicated for Louisiana. Discovery rate in this area is second only to the Utah-Four Corners area this year. Offshore drilling is expected to increase just as fast as new rigs are available—about two a month. Onshore work in southern Louisiana is slower than a year ago, but discovery rate still is high and there are many undrilled locations.

Oklahoma Drilling Activity Declines . . . Although there are no idle heavy-duty rigs, the outlook for medium and shallow capacity rigs is not too bright in Oklahoma. Due to stacking of rigs and machines in eastern and northeastern counties, the completion rate is now some 400 wells behind a year ago—a month-by-month decline since December. There are, however, some bright spots in the picture. A new faulted

LANE-WELLS CANADIAN CO. IN CANADA
PETRO-TECH SERVICE C.A. IN VENEZUELA

LOOKING AHEAD . . .

area north of the Golden Trend in McClain County offers prospects for additional development drilling. Northwestern Oklahoma and the Panhandle sector continue active, but rig operations are not increasing because of pipe line outlets for oil.

Air Drilling Foreseen in Appalachian Area . . . One contractor predicts that air drilling will generally be competitive with cable tools in the Appalachian Province in the future, whereas conventional fluid rotary drilling will not. As rotaries become more prevalent in Appalachian drilling, more wells will be completed with 5½-inch O.D. casing as production string, and correspondingly less of the conventional 7-inch will be run.

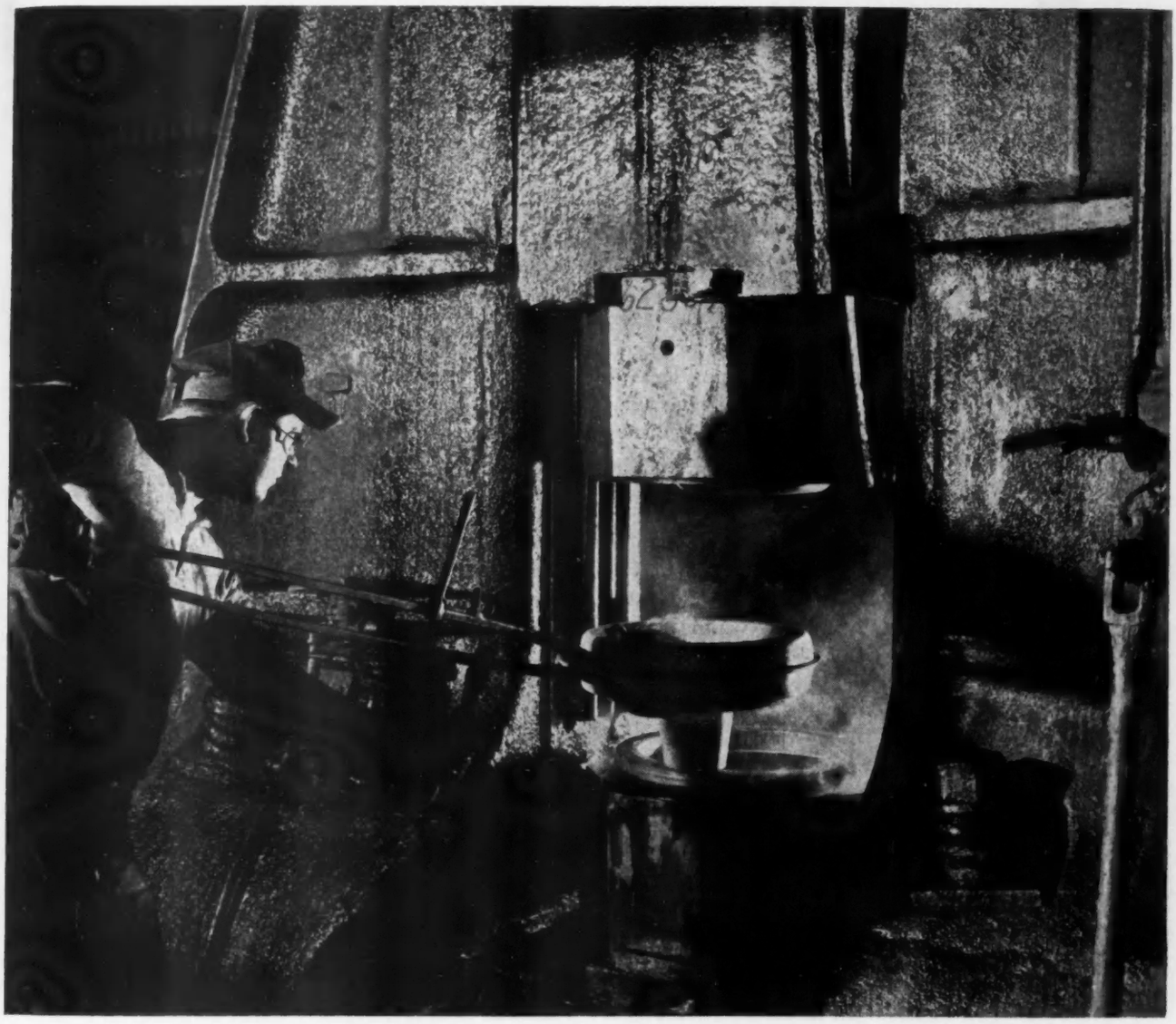
Increased Cuban Activity Seen This Year . . . Important progress in oil development operations in Cuba is expected this year. Several large companies, including Cuban Stanolind, Siboney-Caribbean Petroleum, Shell Oil are reported planning to drill tests on their acreage holdings, which run into millions of acres. Considerable exploratory work will be done. Companies which have completed enough exploratory work are expected to convert their acreage holdings into exploitation concessions, and will probably negotiate a number of important farmouts which will call for drilling commitments this year.

South American Drilling Prospects Vary . . . Interest is stirring anew in Bolivia's northern areas, and the availability of concessions with good oil prospects is expected to lead to new and increased oil activity. . . . Inflation and unrest are continuing to plague efforts of provisional president Pedro Aramburu to sell the Argentine people on quick development of the nation's petroleum reserves as a means of improving Argentina's economy. . . . It is likely that political unrest will hamper indefinitely efforts to open part of Chile to private company operation. However, it is anticipated that Empresa, Chile's government-controlled oil company, will conduct exploration activities in the Puna de Atacama, near Pedernales, where seepages from Jurassic beds are exposed near granite outcrops.

Gas Pipe Line in Pakistan Proposed . . . Further development of the natural gas field at Sylhet in East Pakistan can be expected. The two wells completed have led to an estimate of natural gas reserve of 300,000 MMcf and to the proposal for construction of an 8-inch, 140-mile pipe line from Sylhet to Dacca.

Higher Oil Prices Needed in Mexico . . . A nationwide campaign to convince the whole of Mexico that higher fuel prices are a requisite to the nation's oil industry progress may develop. The nationalized oil industry is being "sacrificed" because it is obliged to sell its products at a loss, says Gustavo P. Serrano, president of Mexican Chamber of the Mining Industry, and Petroleos Mexicanos—the government oil agency—"has no money, cannot drill more wells, will not develop . . . and might suffer a grave collapse."

Tighter Control Over Water-Floods . . . A weaker market for Oklahoma crude may point the way to tighter control on oil produced by water-flooding. So far, water-floods are permitted to produce without restriction. Engineers claim that curtailment will injure the flood projects. The problem is being studied by the Oklahoma Corporation Commission which is debating possible allocation of water-flood oil. It is estimated that 20 percent of Oklahoma's oil is being produced by the water-flooding method. A spirited fight is expected if and when the Commission decides to allocate or prorate water-flood production in Oklahoma.



With Every Blow of the Hammer, Strength is Pounded In

The ram of the forging hammer strikes with an almost incredible force. But it neither shatters nor ruptures the hot steel beneath it. Instead it actually "pounds in" strength, and at the same time causes the steel to be shaped by the dies.

The photograph above shows an everyday occurrence in the Bethlehem drop-forge shops. There a large battery of steam and board drop hammers is constantly at work, pounding out strong, sturdy forgings of many different designs. Some of these pieces weigh as little as a pound. Others, like the one in the picture, run big.

For years Bethlehem has been making drop and other closed-die forgings for the petroleum, mining, aviation, automotive, and electrical industries, to name but a few. Both quality and variety are assured by excellent facilities, which include die-sinking shops, hammers to 8,000 lb, mechanical presses to 3,000 tons, and full heat-treating equipment.

Bethlehem drop forgings are available in weights ranging from one to 250 lb. No matter what size or design you require, we can handle it to your entire satisfaction. Call us when next in the market.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

BETHLEHEM STEEL

Good Wells Make Good News

June, 1957

RIVERFRAC*, an exciting new concept in hydraulic fracturing, is finding widespread use in many oil and gas producing areas. Large volumes of fresh water or unsaturated salt water are pumped into the producing zone at a high injection rate. Many authorities think salt removal is an important reason why Riverfrac is successful in some cases where other fracturing treatments have failed. Here are some results of Riverfrac.

- **Ward County, West Texas** (Old Well): This well, completed in the Yates at 3000 feet, had declined from 10 bopd to 1 bopd in about 18 months. Riverfrac, using 22,000 gallons of fresh water and 10,000 pounds of sand, removed 18,920 pounds of salt. Average injection rate was 34 bpm. *90 days after fracturing, well tested 115 bopd.*

- **Washington County, Illinois** (New Well): This well was completed in the Trenton Lime 4290-4400 feet open hole. Initial test was show of oil. Riverfrac was used. Fluid was 67,000 gallons fresh water with addition agents to control silicate swelling and emulsions. 55,000 pounds of sand was used. Fracturing was accomplished at average injection rates of 40 bpm. Although only 3600 pounds of salt was recovered, *well tested 95 bopd after treatment.*

- **Kay County, Oklahoma** (New Well): Completed in the Mississippian Chat 4154-4180, tested 6 bopd before treatment. Well was treated with Riverfrac, using 20,000 gallons of water with 20,000 pounds of sand at 37 bpm. *70 days following treatment, production tested 65 bopd with 40 bwpd.*

- **San Juan County, New Mexico** (New Well): Completed in Point Lookout Sandstone. Depth, 4805-5034 with four sets of perforations totaling 117 feet. Riverfrac was used. 256,196 gallons fresh water and 180,000 pounds sand were injected in four stages at 59-78 bpm. 160 rubber-coated nylon ball-sealers were used in one stage. Initial production: 30,000 cfpd. After treatment, well tested 7,400,000 cfpd. through ¾-inch choke at 506 psi. *Production was increased 247 times!*

Call Dowell. An experienced engineer will be glad to show you what's being done with Riverfrac in your area and discuss the possibilities of using this service in your wells. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

Services for the oil industry DOWELL

A Service Subsidiary of The Dow Chemical Company

*Service Mark of Dowell Incorporated

Let the Consumer Decide

Consumers are the finest of people. Naturally. Nearly all of us buy products.

When properly informed—allowed to weigh both sides of an issue—they are usually fair in their judgment. When not properly informed they can foment untold problems for an industry.

An excellent example is the plight of natural gas producers in Washington. At the last report only two facts were certain in the Harris-O'Hara Natural Gas Bill debate:

- The producers don't like the bill in its present form.
- They are even more strongly opposed to the two amendments the Eisenhower administration has added.

In fact, there is general concurrence that the amendments—allowing the Federal Power Commission to use cost as a basis for determining producer prices and to review definite pricing clauses in gas contracts—would keep natural gas producers in the same untenable position they have occupied since the 1950 Phillips decision. Only this time federal control of wellhead prices would be sanctioned by an act of Congress instead of Supreme Court "legislation."

Serious economic problems would be created by such a bill for the oil industry, the consumer and the nation. This fact has been backed up by statistics time and again in producers' arguments before countless committees in the Phillips Case—in support of the Kerr Bill—in support of the Harris Bill—and in debating the Harris-O'Hara Bill.

Such a bill would give advocates of creeping socialism the wedge they have been waiting for. Once the foot is in the door, there will be nothing to stop the federal government from controlling each industry operating "in the public interest." This would include every segment of the oil industry, all minerals, every commodity with a price tag. The consumer, as well as industry, will be the loser. History has proved that federal control of anything dries up the source of supply—puts a steel band of red tape around progress.

Such a bill would tend to keep natural gas within the limits of the states producing it. To give but one example of how this is already happening, 27 years ago Texas marketed within its borders only 25.7 percent of the natural gas it produced. The percentage was 52.1 in 1955. Of the 4.7 trillion cubic feet of natural gas marketed in Texas last year, transmission lines took 4.1 trillion cubic feet, and exported only 2.5 trillion. Consumers in non-gas producing states are the losers. They can't use an inexpensive, efficient fuel they can't get.

These are just a few of the ill effects that will continue if the Harris-O'Hara Bill is passed in its present form. If this is all that producers can accomplish after seven years of trying to reason with Washington legislators, perhaps another approach should be considered.

Why not take the facts to the "Grass Roots"? Here is the reasoning behind this suggestion:

Senators and Congressmen represent the residents of their respective areas. They are representing the interests of those people, thus they will consider an issue in accordance with the wishes—or votes—of the majority. Whether fairness (or votes) is the guiding force in decisions to back or oppose a bill might well be a question.

There is only one hitch in this premise. Sometimes the people know only one side of an issue, and end up asking for support of a half-truth.

People in some areas believe (many are told) the price they pay for natural gas is too high. They have been told the producer is the culprit. Their city leaders, and some consumer groups, put pressure on their Washington legislators to hold back on natural gas prices, even if it means federal control of producers. The result: A Harris-O'Hara Bill goes in the hopper.

The people can hardly be blamed. They know only what they have been told. And they have been told little or nothing about the producers' side of the issue—nor have they been told of the dangers of federal control of industry. Yet the feelings of these people determine the actions of their senators and congressmen!

This should be reason enough to take the producers' story to the consumers. There is just one word of caution: The success of any "Grass Roots" effort depends entirely upon education through logic and reason. It is not only *what* is said that counts—but *how* it is said.

Why not give the consumer a chance? He could be the producers' staunchest supporter.

After the two leaders, four other

Independents Produce 37.6% Of Crude Petroleum in U. S.

Thirty-eight larger companies accounted for 62.4% of U. S. output in 1956. Jersey Standard led.

THIRTY-EIGHT larger companies in 1956 accounted for 62.4 percent of U. S. crude oil production. Their gross production averaged 4,462,055 barrels daily. Thousands of smaller companies and independent operators provided the remaining 37.6 percent of U. S. output. Together they produced 2,689,398 barrels per day.

The bigger concerns somewhat increased their proportion of the country's production during 1956. In 1955 they had produced 62.1 percent of the total. The independents, conversely, produced a smaller part of the national output in 1956 than the year before. In 1955 they had accounted for about 37.9 percent. (WORLD OIL, June 1956, Page 102.)

Apparently, the large companies in 1956 stepped up their purchases of producing properties from independents. Most of them also intensified their exploratory and field development drilling. Also boosting production of the large companies perhaps relatively more than that of many independents was the stepping up of output late in 1956 to supply emergency European demand. Flush production from big company leases in Texas, Louisiana, and Mississippi figured prominently in supplying Europe.

Jersey Units at Top. Heading the list of individual companies in U. S. crude production in 1956 was Standard Oil Company (New Jersey). Its two domestic affiliates produced 436,179 barrels of crude per day. That was 6.1 percent of the U. S. total. Jersey had led also in 1955, with production of 414,300 barrels daily, likewise 6.1 percent of the national total.

The Texas Company again ranked No. 2 and produced 5.7 percent of the U. S. total output, having averaged 405,349 barrels daily in 1956, compared with 394,302 barrels per day in 1955.

Humble Oil & Refining Company, big affiliate of Jersey Standard, itself ranked No. 3 in production. It averaged 371,029 barrels daily or 5.2 percent of the U. S. total in 1956, compared with 357,300 barrels daily or 5.2 percent of the national output in 1955.

Shell Oil Company was the No. 4 producer in 1956, as in 1955. It averaged 304,145 barrels daily, or 4.2 percent of the U. S. total.

Three companies in the No. 5, No. 6, and No. 7 positions produced nearly the same volumes in 1956, each reporting around 275,000 to 285,000 barrels daily, or almost 4 percent of the U. S. total. They were Gulf Oil Corporation, Standard Oil Company (Indiana), and Standard Oil Company of California.

Not far behind them was Socony Mobil Oil Company, in No. 8 position, with 237,125 barrels daily, or 3.3 percent of U. S. production.

Continental Oil Company was No. 9 in crude output. It produced 137,672 barrels daily, or 1.9 percent of the U. S. total.

Phillips Petroleum Company rated No. 10. It averaged 133,115 barrels daily, or 1.9 percent of the national total.

—**The End**

Net Domestic Crude Oil Production of Some U. S. Companies in 1956

(Company's net share; does not include royalty and co-owner interests.)

Data from all available annual reports of U. S. companies with crude production and/or refinery runs above 10,000 barrels daily.

Company and Rank in Production	Total Barrels	Barrels Daily	% of U.S.
1. Standard Oil Company (N.J.)	159,641,542	436,179	6.10
2. The Texas Company	148,357,734	405,349	5.67
3. Humble Oil & Refining Co	135,796,542	371,029	5.19
4. Shell Oil Company	111,317,000	304,145	4.25
5. Standard Oil Company (Ind.)	*104,576,448	*285,728	4.00
6. Gulf Oil Corporation	104,013,000	284,186	3.97
7. Standard Oil Company of Calif.	100,379,526	274,261	3.83
8. Socony Mobil Oil Company	86,878,750	237,125	3.31
9. Continental Oil Company	50,387,952	137,672	1.92
10. Phillips Petroleum Company	48,720,209	133,115	1.86
11. Sinclair Oil Corporation	45,312,264	123,804	1.73
12. Sun Oil Company	*44,737,398	*122,233	1.71
13. Cities Service Company	*44,263,000	*120,937	1.69
14. Union Oil Company of Calif.	37,728,000	103,082	1.44
15. Ohio Oil Company	35,469,262	96,911	1.36
16. Atlantic Refining Company	*35,343,522	*96,567	1.35
17. Tidewater Oil Company	33,800,000	92,350	1.29
18. Amerada Petroleum Corp	32,872,616	89,816	1.26
19. Sunray Mid-Continent Oil Co.	*30,301,268	*82,790	1.16
20. Skelly Oil Company	26,167,865	71,497	1.00
21. Pure Oil Company	24,554,000	67,087	0.95
22. Carter Oil Company	23,845,000	65,150	0.91
23. Richfield Oil Corporation	20,743,000	56,675	0.79
24. Seaboard Oil Company	14,701,854	40,169	0.56
25. Standard Oil Company (Ohio)	11,606,958	31,713	0.44
26. British American Oil Prod. Co.	9,362,000	25,579	0.36
27. General American Oil Co. of Tex.	8,203,202	22,413	0.31
28. Monsanto Chemical Company (Lion Oil Company Div.)	8,163,161	22,304	0.31
29. Texas Pacific Coal & Oil Co.	7,580,065	20,711	0.29
30. United Gas Corporation	6,942,924	18,970	0.27
31. Plymouth Oil Company	5,602,230	15,307	0.22
32. Champlin Oil & Refining Co. (Was Chicago Corporation)	5,089,889	13,907	0.20
33. Arkansas Fuel Oil Corporation	4,955,640	13,540	0.19
34. Texas Gulf Producing Company	4,947,000	13,516	0.19
35. Anderson-Prichard Oil Corp.	4,769,346	13,031	0.18
36. Argo Oil Corporation	3,823,744	10,447	0.15
37. South Penn Oil Company	3,677,934	10,049	0.14
38. Colorado Oil & Gas Corp.	2,313,909	6,322	0.09
39. Delhi-Taylor Oil Corporation	1,760,000	4,809	0.07
†Total, 38 Companies	1,428,973,212	3,904,298	54.59
Royalty and Co-Owner Oil Produced, Est.	204,139,030	557,757	7.80
Gross Production, Above Co.'s	1,633,112,242	4,462,055	62.39
Remainder of Industry	984,319,758	2,689,398	37.61
Total, United States	2,617,432,000	7,151,453	100.00

* Includes natural gas liquids. † Totals exclude Standard (N. J.), whose U. S. affiliates, Humble and Carter are included.

Gulf Oil and Texas Company Lead in U. S. 1956 Drilling

Thirty-four larger companies drill only 22% of the wells completed, while independents drill 78%.

THIRTY-FOUR larger oil companies in 1956 drilled only 22 percent of the wells completed in the U. S. Smaller companies and independent operators drilled the remaining 78 percent, or nearly four out of every five wells completed.

The 34 larger concerns drilled about 12,823 net wells. The thousands of other operators drilled the other 45,383 wells.

These figures have been arrived at through the tabulation herewith. It is based on information reported by the larger companies in their annual reports to their stockholders.

The figures are necessarily partially estimated, as some companies reported only gross wells that they participated in.

Gulf Ranks First. Heading the list of companies in drilling in 1956 were Gulf Oil Corporation (No. 1) and The Texas Company (No. 2). Gulf reported the completion of 1388 net wells during the year in the U. S. The company apparently participated in the drilling of some 2000 gross wells, if its ratio of gross to net was similar to the proportions of most other companies. Gulf had ranked second in drilling in 1955.

The Texas Company dropped to second place in 1956 from first in 1955, having drilled 1792 gross wells in 1956.

After the two leaders, four other companies ranked close together, having drilled only slightly different numbers of wells. Standard Oil Company (New Jersey) through two domestic affiliates drilled 1275 gross wells. Standard Oil Company (Indiana) reported 1227 gross and 824 net wells for No. 4 rank. The company had ranked 10th with 555 net wells in 1955. Shell Oil Company in 1956 drilled 1132 gross wells, vs. 899 in 1955, but dropped to No. 5 rank from No. 3 Humble Oil & Refining Company, big affiliate of Standard (N. J.), itself ranked No. 6 in 1956 with 1059 gross wells, against 841 the year before.

Following the top six companies in drilling, roughly in this order, were: No. 7 Standard Oil Company of California, No. 8 Continental Oil Company, No. 9 Socony Mobil Oil Company, No. 10 Sun Oil Company, No. 11 Phillips Petroleum Company, No. 12 Sinclair Oil Corporation, No. 13 Sunray Mid-Continent Oil Company, No. 14 Ohio Oil Company, and No. 15 Skelly Oil Company.

Then came Cities Service Company, The Atlantic Refining Company, Tidewater Oil Company, Amerada Petroleum Corporation, Union Oil Company of California, and (No. 21) The Pure Oil Company.

—The End

Number of Wells Completed in U. S. in 1956 by Larger Companies

Data from all available annual reports of U. S. companies with crude production and/or refinery runs above 10,000 barrels daily.

Company and Approximate Rank in Drilling	[1]Gross Wells	[2]Net Wells
1. Gulf Oil Corporation	[3]2,103	1,388
2. The Texas Company	1,792	.....
3. Standard Oil Company (N.J.)	1,275	.....
4. Standard Oil Company (Ind.)	1,227	824
5. Shell Oil Company	1,132	.....
6. Humble Oil & Refining Company	1,059	.....
7. Standard Oil Company of Calif.	....	[4]973
8. Continental Oil Company	925	595
9. Socony Mobil Oil Company	902	.....
10. Sun Oil Company	673	543
11. Phillips Petroleum Company	808	509
12. Sinclair Oil Corporation	....	491
13. Sunray Mid-Continent Oil Co.	662	424
14. Ohio Oil Company	657	.....
15. Skelly Oil Company	589	411
16. Cities Service Company	591	.....
17. Atlantic Refining Company	....	276
18. Tidewater Oil Company	427	225
19. Amerada Petroleum Corporation	427	.....
20. Union Oil Company of Calif.	377	.....
21. Pure Oil Company	....	217
22. South Penn Oil Company	....	208
23. Carter Oil Company	216	.....
24. Anderson-Prichard Oil Corp.	207	.....
25. British American Oil Prod. Co.	200	.....
26. Monsanto Chemical Company (Lion Oil Company Division)	191	120
27. Standard Oil Company (Ohio)	187	115
28. Plymouth Oil Company	127	.....
29. Texas Pacific Coal & Oil Company	115	78
30. Colorado Oil & Gas Corporation	125	73
31. Argo Oil Corporation	104	.....
32. Richfield Oil Corporation	[5]85	[5]66
33. United Gas Corporation	83	.....
34. Texas Gulf Producing Company	77	47
35. Delhi-Taylor Oil Corporation	64	41
[6]Total 34 Companies	....	[7]12,823
(Percent of U.S.)	....	22.0
Rest of Industry	....	45,383
(Percent of U.S.)	....	78.0
Total, United States	....	58,206

[1] Includes wells owned jointly with others. [2] Company's net share. [3] Estimated here for purpose of ranking companies. [4] Total Western Hemisphere. [5] Productive wells only. [6] Excludes Standard (N.J.), as its affiliates, Humble and Carter are included. [7] For companies that reported only gross wells, net wells are here estimated as 66% of gross, as indicated by reports showing both gross and net wells.

Independents Do Big Part Of Drilling in All Areas

Smaller operators in 1956 drilled from 60 to 100 percent of wells in all but a few districts.

INDEPENDENT OPERATORS and smaller companies drill about 4 out of every 5 wells drilled for oil and gas in the U. S. There are thousands of the smaller operators. They drill a majority of the wells in nearly all states and major districts.

Among the few exceptions are North Dakota and South Louisiana, where the larger companies have been drilling over 60 percent of the wells completed. North Dakota has large lease blocks held by major companies and has deep and relatively expensive drilling to account for the large share of development by the large concerns.

Similarly, big companies predominate in South Louisiana partially because of the large amounts of capital required to operate there. The district has the deepest drilling in the U. S., with many wells going down to 12,000 or 15,000 feet. Also, much of the drilling is offshore, where even major companies drill jointly to ease the burden of the heavy development costs.

Independent operators in 1956 drilled about 46,000 wells, or 79 percent of the 58,206 completed in the U. S. This is indicated by the table herewith, based on information on the drilling done by 22 major companies.

The independents in 1956 drilled about 86 percent of all wells drilled for oil and gas in Texas. They accounted for more than 63 percent of the wells in each district of the state.

In Oklahoma, second most active state, independent operators in 1956 drilled 82.6 percent of all wells.

Kansas, No. 3 state in drilling, had a similar situation. The small operators drilled about 85 percent of the wells in the state.

In Louisiana, No. 4 state, independents drilled 58 percent of all wells, as they accounted for 87 percent in North Louisiana, though drilling only 36 percent in South Louisiana.

Illinois was fifth most active state. Of its wells, 80 percent were put down by the smaller operators.

In California, No. 6 state in well completions, independents drilled only a little over one half of all wells, accounting for 51.4 percent, as major companies drilled 48.6 percent.

In both Indiana and Kentucky, where wells are predominantly shallow, about 97 percent of the drilling in 1956 was done by independent operators.

Similarly, virtually all drilling was done by independent operators in the Appalachian states of New York, Pennsylvania, Ohio, and West Virginia.

Independents drilled 87 percent of the wells in Colorado, 75 percent in Wyoming, 60 percent in Montana, and 53 percent in Utah. —**The End**

Independent Operators Drilled Large Proportions of Wells in All States in 1956

(Table is based on data reported by 22 larger companies)

STATE or DISTRICT	Total Wells Drilled	22 Major Companies*		Rest of Industry	
		Wells	% of Total	Wells	% of Total
Alabama	90	37	41.1	53	58.9
Arkansas	1,025	99	9.6	1,926	90.4
California	2,201	1,070	48.6	1,131	51.4
Colorado	1,265	164	13.0	1,101	87.0
Illinois	3,650	729	20.0	2,921	80.0
Indiana	707	22	3.1	685	96.9
Kansas	4,643	690	14.9	3,953	85.1
Kentucky	1,866	55	3.0	1,811	97.0
Louisiana	3,803	1,599	42.0	2,204	58.0
North Louisiana	1,651	219	13.3	1,432	86.7
South Louisiana	2,152	1,380	64.1	772	35.9
Michigan	438	28	6.4	410	93.6
Mississippi	435	95	21.8	340	78.2
Montana	503	203	40.4	300	59.6
Nebraska	888	182	20.5	706	79.5
New Mexico	1,967	663	33.7	1,304	66.3
New York	517	.....	....	517	100.0
North Dakota	280	177	63.2	103	36.8
Ohio	1,026	33	3.2	993	96.8
Oklahoma	7,642	1,326	17.4	6,316	82.6
Pennsylvania	954	.....	....	954	100.0
South Dakota	21	4	19.0	17	81.0
Texas	22,361	4,730	14.2	17,631	85.8
R.R. Comm. District—					
1: South Central	1,994	391	19.6	1,603	80.4
2: Middle Gulf	814	153	18.8	661	81.2
3: Upper Gulf	1,827	571	31.3	1,256	68.7
4: Lower Gulf- S.W.	1,450	245	16.9	1,205	83.1
5-6: East Central and North East	1,205	207	17.2	998	82.8
7B-9: North Central and North	8,082	633	7.8	7,449	92.2
7C-8: West Central and West	5,592	2,026	36.2	3,566	63.8
10: Panhandle	1,397	504	36.1	893	63.9
Utah	146	69	47.3	77	52.7
West Virginia	698	2	0.3	696	99.7
Wyoming	964	242	25.1	722	74.9
Other States†	107	14	12.1	99	87.9
Total United States	58,206	12,233	21.0	45,973	79.0

* Amerada, Atlantic, Carter, Cities Service, Continental, Gulf, Humble, Ohio, Phillips, Pure, Richfield, Shell, Sinclair, Socony-Mobil (Magnolia and General), Stand. of Calif. (California Co. and Stand. of Tex.), Standard of Indiana (Stanolind and Pan-American), Standard of Ohio (Sohio), Sun, Sunray Mid-Continent, The Texas Co., Tide Water, and Union.

† Ariz., Fla., Ga., Idaho, Md., Mo., Nev., Ore., Tenn., Va., Wash.

Independents Do About 14% Of U. S. Refining; Majors 86%

Thirty larger companies in 1956 produced in U. S. only one half of their crude requirements. Remainder was purchased from others or imported.

THIRTY LARGER oil companies in 1956 accounted for 88.4 percent of U. S. crude runs to refinery stills. Their combined runs to stills averaged 7,018,035 barrels daily.

In addition to the so-called major companies, the 30 companies here considered included half a dozen or so prominent independent companies, which together accounted for about 2 percent of U. S. refinery runs. (See table.)

The major companies alone therefore accounted for about 86 percent of the country's refining, and the independents about 14 percent.

Companies other than the 30 larger concerns included in the accompanying table are indicated to have run to stills 919,413 barrels of crude per day in 1956. That was 11.6 percent of the U. S. total.

All companies in the group of 30 were domestic producers as well as refiners except one independent refiner and one major refiner that has producing affiliates. The 30 larger companies in the aggregate produced in the U. S. only 51.8 percent of the crude they refined. They bought from royalty owners and other domestic producers and imported almost one-half of their crude requirements. Total domestic crude production by all producers was equivalent to only 90.1 percent of total crude runs to stills at U. S. refineries.

Standard Oil Company (New Jersey) remained the foremost U. S. refiner. Its affiliates in 1956 ran to stills an average of 826,800 barrels of crude per day, or 10.4 percent of the national total. Jersey's runs in 1955 averaged 784,000 barrels daily and were 10.5 percent of U. S. runs.

Gulf Oil Corporation climbed to second place. Its runs of 667,806 barrels daily were 8.4 percent of the U. S. total. In 1955, Gulf processed 587,867 barrels daily, or 7.9 percent of U. S. runs, and was No. 3 refiner.

Standard Oil Company (Indiana) dropped to third place from second. It ran to stills 642,343 barrels daily in 1956, or 8.1 percent of U. S. runs. In 1955 it had processed 601,482 barrels daily, or 8 percent.

The Texas Company continued as No. 4 refiner. Runs of 607,767 barrels daily were 7.7 percent of U. S. In 1955 the runs of 574,001 barrels per day also represented 7.7 percent.

Socony Mobil Oil Company remained No. 5 in refining. Its 1956 runs were 563,708 barrels daily, or 7.1 percent of U. S. In 1955 its runs averaged 545,553 barrels daily or 7.3 percent.

Esso Standard Oil Company, affiliate of Standard Oil Company (New Jersey) ranked No. 6 in 1956, with runs of 542,000 barrels daily or 6.8 percent of the U. S. total. In 1955 runs of 517,000 daily were 6.9 percent.

Next in order among the U. S. refining companies were Standard Oil Company of California, Shell Oil Company, Sinclair Oil Corporation, Humble Oil & Refining Company, Sun Oil Company, Cities Service Company, Phillips Petroleum Company, Atlantic Refining Company, Tidewater Oil Company, Union Oil Company of California, The Pure Oil Company, Continental Oil Company, Standard Oil Company (Ohio), Richfield Oil Corporation, Sunray Mid-Continent Oil Company, Skelly Oil Company, The Ohio Oil Company and Plymouth Oil Company.

—The End

Domestic Refinery Runs and Crude Oil Production of Some U. S. Companies in 1956

(Data from all available annual reports of U. S. companies with refinery runs and/or crude production above 10,000 barrels daily.)

COMPANY and RANK IN REFINING	CRUDE RUNS TO STILLS			CRUDE OIL PRODUCTION	
	Total Barrels	Barrels Daily	Percent of U.S.	Barrels Daily	% of Runs to Stills
1. Standard Oil Co. (New Jersey)§	302,608,800	826,800	10.42	436,179	52.8
2. Gulf Oil Corporation	244,417,000	667,806	8.41	284,186	42.6
3. Standard Oil Company (Indiana)	235,097,538	642,343	8.09	*285,728	44.5
4. The Texas Company	222,442,722	607,767	7.66	405,349	66.7
5. Socony Mobil Oil Company	206,317,128	563,708	7.10	237,125	42.1
6. Esso Standard Oil Company	198,372,000	542,000	6.83	.....	....
7. Standard Oil Co. of California	184,537,200	504,200	6.35	274,261	54.4
8. Shell Oil Company	182,184,000	497,770	6.27	304,145	61.1
9. Sinclair Oil Corporation	163,903,411	447,824	5.64	123,804	27.6
10. Humble Oil & Refining Company	95,818,800	261,800	3.30	371,029	141.7
11. Sun Oil Company	95,068,435	259,750	3.27	*122,233	47.1
12. Cities Service Company	94,539,000	258,303	3.25	*120,937	46.8
13. Phillips Petroleum Company	89,583,995	244,765	3.08	133,115	54.4
14. Atlantic Refining Company	75,316,212	205,782	2.59	*96,567	46.9
15. Tidewater Oil Company	65,412,984	178,724	2.25	92,350	51.7
16. Union Oil Company of California	61,453,000	167,904	2.12	103,082	61.4
17. Pure Oil Company	59,820,000	163,443	2.06	67,087	41.0
18. Continental Oil Company	51,596,484	140,974	1.78	137,672	97.7
19. Standard Oil Company (Ohio)	51,285,644	140,125	1.77	31,714	22.6
20. Richfield Oil Corporation	44,479,000	121,527	1.53	56,675	46.6
21. Sunray Mid-Continent Oil Co	38,843,332	106,129	1.34	*82,790	78.0
22. Skelly Oil Company	16,930,500	46,258	0.58	71,497	154.6
23. Ohio Oil Company	15,526,128	42,421	0.53	96,911	228.5
24. Plymouth Oil Company†	14,458,000	39,503	0.50	15,307	38.7
25. Delhi-Taylor Oil Corporation	14,300,000	39,071	0.49	4,809	12.3
26. Anderson-Prichard Oil Corp.	10,745,760	29,360	0.37	13,031	44.4
27. Clark Oil & Refining Corporation	10,572,940	28,888	0.36	.....	....
28. Carter Oil Company	8,418,000	23,000	0.29	65,150	283.3
29. Monsanto Chemical Company (Lion Oil Company Division)	8,393,703	22,934	0.29	22,304	97.3
30. Colorado Oil & Gas Corporation‡	5,138,351	14,039	0.18	6,322	45.0
31. South Penn Oil Company	3,629,622	9,917	0.12	10,049	101.3
§Total 30 Companies	2,568,600,889	7,018,035	88.42	3,635,229	51.8
Remainder of Industry	336,505,111	919,413	11.58	3,516,225	382.4
Total, United States	2,905,106,000	7,937,448	100.00	7,151,454	90.1

* Includes natural gas liquids. † Refining was by affiliate, Republic Oil Ref. Co., at Texas City, Tex., Republic is now merged with Plymouth. ‡ Refining is by wholly owned subsidiary, Derby Ref. Co., at Wichita, Kans. § Total excludes Standard (N.J.), whose U.S. affiliates, Carter, Esso Standard, and Humble, are included.

Beware of These Time-Killers

Many executives are getting increasingly suspicious that this business of meetings is being overdone.

The most useful office fixtures can often be the most deadly time-consumers. Here's how you can streamline your workload.

By **ROBERT E. JOHNSON,** United Air Lines, Chicago

ONE OF THE GREAT problems confronting management is the proper application of time. An 8-hour office day has only 480 minutes. But the average executive's work day is more than eight hours. However, if he is to be more productive, he must make the most of the office time available to him.

From one view point the very offices in which executives work represent obstacle courses in the path of increased management efficiency. The first element in an office that can create trouble is the desk.

Most executives have desks, most believe they need them in the transaction of their business, and perhaps that's so. Executives make a bee-line for the desk when they reach the office, and because it represents a symbol of office life, have a tendency to spend too much time in that one spot. As a result many executives are unable to accomplish some very important aspects of management responsibilities.

We all know that a desk is a trap for paper work. As long as a desk has a drawer or several drawers it's going to accumulate papers. Many executives practice the experiment from time to time called "cleaning out our desk" and it's always a revelation to discover how unimportant some of the material in the desk has become when on receipt it appeared so vital.

Some executives get around this problem by not using a desk. They found by using lounge furniture in their offices and perhaps a telephone table they've been able to escape some of the problems that are created by the desk. But whether you get rid of a desk or not is immaterial. The main point, and this is step one in the elemental do-it-yourself, is to recognize that you must be master of your desk rather than servant.

That Goes for Letter Baskets, too. The next familiar piece of equipment in our offices is what we might call the letter basket. It can be a letter box on the desk, it can be a drawer on the desk. It can be the folder that the secretary brings in, but it represents business correspondence and that represents another deterrent to maximum efficiency of management action.

Many executives have assistants and secretaries who are very helpful in screening out correspondence, in handling minor matters, in passing up only those things which require policy or action at management level. But correspondence is an insidious thing and unless guarded against, the executive will find he is spending more of those 480 minutes a day in correspondence that might well be delegated.

Another sore point is the abuse of correspondence that takes place. About two months ago our company conducted a very interesting experiment. We collected from the mailing department all of the mimeographed material, all of the sales bulletins, all of the reports that were sent out during the period of one week to our sales offices in the field, and that made quite a pile.

But as we went through that pile with the managers and supervisors who were responsible for creating that flood of paper to the field, we found that 50 percent of that material could either have been eliminated or pruned substantially! Yet it was

Another sore point is the abuse of correspondence that goes on.

The Telephone—the third, and most time-consuming piece of office furniture.

About the Author

ROBERT E. JOHNSON, vice president and assistant to the president of United Air Lines, is an aviation industry veteran. He began his airline career in 1929 with the Boeing Airplane Co. In 1938, Johnson became director of advertising and publicity for United. In 1951, he was elected a vice president of United in charge of public relations, publicity and advertising activities. In 1953, he also assumed direction of United's sales administration. He was elected to United's board of directors in 1954.

eating up valuable time in its production and valuable time in the field. By the same token we examined the reports coming in from our sales offices in the field and found that a high percent were reports that no longer fulfilled their original purpose and others were susceptible to modernization.

These are three excellent solutions to the letter box bottleneck. Delegate as much correspondence as possible—handle what can be handled promptly—cut out unnecessary correspondence.

Then There's the Telephone. The third, and most time consuming piece of office furniture, is the telephone. We can't do business today without the telephone much as some of us would like to try it from time to time. But we can do business more efficiently by recognizing the danger that's inherent in the time lost every time it rings.

Executives understand the problem created by the interruption feature of the telephone. They might be engaged in creative thinking and then find the telephone calls interrupt and disturb their thought trends. Some executives deal with the pesky problem by shutting off the telephone from time to time. But this is not always practical. The most important thing to bear in mind is that it's so easy to waste time on a telephone and also so easy to make unnecessary calls. That takes time and money.

Let's give a quick example of how the telephone by its very convenience can create unnecessary telephone traffic. One company links its executive offices in Chicago with its operating headquarters in Denver, and its maintenance headquarters in San Francisco, with a direct private telephone line. Recently I placed a call in the early part of the afternoon for one of our officials in Denver and my secretary informed me that there were 18 calls ahead of me, and if I wanted the call completed that day I should make it outside by long distance.

Because I was interested in the subject of streamlining the executive workload I asked the switchboard if, in routine fashion, she would check the supervisors to find out if the purpose of the calls could be served equally well by telegram or even an air mail letter. As a result of that survey 12 out of the 18 calls were cancelled. That illustrates the temptation of the telephone.

Discourage Visiting Firemen. The fourth piece of time wasting office equipment is the visitor's chair. That is a very essential piece of any office furniture. If it's not being used, if it's getting dusty then we can become disturbed over our own business progress. But the fact remains, many occupants of the visitor's chair are not sensitive to the value of the time of the gentlemen on whom he is calling.

A book recently published called "How to Gain An Extra Hour Every Day" by Ray Josephs recognizes the problem of inroads on executives' time by people who come in without a concise businesslike presentation of the point of the interview. One of the author's suggestions to deal with that type of situation is to look at the ceiling or out the window occasionally.

The main thing is that if we recognize the attrition in time represented over the year by the visiting firemen, polite as we may be to them, we must then develop a more businesslike desk side manner.

Clock Your Conferences. Finally there's one other element of the executive's office that deserves attention—the conference table.

In this modern day of American business a many actioned group discussion of plans and policies has become essential, and obviously along with that we have the conference table. A lot of executives are getting increasingly suspicious that this business of meetings is being over done.

Fundamentals Involved. Now let's take a look at some of the real fundamentals involved in this question of

streamlining the executive work load.

First is the very organization in which we work. Even though the organization of one company and another may differ, fundamentally they're tailored to the concept of concentration of policy and authority and decentralization of work.

We all have our organizations, we have our assistants, we have our staff —but we are not using, in all cases, the organizations which have been tailored to our needs, as we should use them. This business of delegation is a much talked about, but very sensitive area.

If an executive is really interested in checking whether an item should be delegated it can be subjected to certain questions such as these:

1. Is it a policy item?
2. Is it repetitive or retained?
3. Are there subordinates who have the ability and all the facts to make this type of decision?
4. Is there really a choice? Can he even consider spending time on this area in relation to other items of far greater importance?

One type of business philosophy which always lightens the executive work load requires a change in approach on the executive's part from participating fully in every activity to concentrating on developing measurements which will get across to his people what he expects of them, and then a simple report on how well they are doing.

Communications. Another point involved in this matter of executive streamlining is communications. We all know that a well-informed organization is a more productive organization, but sometimes we forget about it and sometimes we make work for ourselves by our failure to communicate the philosophy of our policies and plans to those whom we expect to execute them. Sometimes we can save time by properly communicating information on what we want done at the time we make the delegation. In other words delegation means communication as an important adjunct.

To insure that you are doing your share in streamlining the executive work load—make this simple little check—"Have you some time each day to relax in your office and get some perspective on the over-all problems ahead?" —**The End**

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

•

- Last year, gasoline-driven vehicles of all kinds traveled a distance equal to 31 round trips to each of the eight other planets in our solar system, with a few billion miles left over for detours.

•

- Ninety-five percent of the 65 million meals served daily in public dining rooms are cooked with natural gas.

•

- The drilling rig, often as high as a 15-story building, is so skillfully engineered that it can lift and lower equipment weighing as much as five locomotives.

•

- If present trends continue, 25 years from now our petroleum needs will equal the lifetime output of an East Texas oil field every year. But the present rate of oil exploration and discovery shows that the petroleum industry can meet this need—and more.

•

- By reducing wear, modern, high-quality motor oils can triple the life of a car engine.

•

- The 48 states have collected over 26 billion dollars in gasoline taxes in the last quarter century. These funds have been the greatest single source of funds for building roads and highways.

•

- More than 3 billion gallons of petroleum fuels were used last year by farm tractors alone. The greater portion—83.7 percent—was gasoline. The balance was comprised of kerosine and other fuels.

•

- A new service station road map usually represents an investment of more than $20,000 before a single copy is printed for distribution.

•

- Today, U. S. producing wells turn out more than 6 million barrels of petroleum daily—almost three times the volume produced 25 years ago.

•

- In just 25 years, total mileage of petroleum product pipe lines jumped more than twenty-seven-fold—from 1289 miles to 36,735 miles of pipe line.

Modern Trends in Oil Accounting

Old methods are no longer practical in an industry beset by increased government regulations, growing complexity of tax laws and mounting pressure of competition.

By **FOSTER PARKER**
Brown & Root, Inc.
Houston

OIL INDUSTRY accounting requirements are changing rapidly. Here are the reasons:

- Increased government regulations.
- Growing complexity of tax laws.
- Trend toward diversification and decentralization.
- New developments in automation.
- Increased management requirements for timely data to meet competitive pressures.

Consequently, the oil accountant is seeking a broader knowledge and understanding of his place in corporate management and of the task he is assigned to perform. From all indications the factors which have caused this need for information are here to stay. Key words as to what's ahead in oil accounting are forward thinking and planning, plus future developments which may be visualized in four general areas:

1. Accounting Research. Accounting research falls into two broad categories. One is the constant study and analysis of the great mass of data produced by today's modern accounting system to locate a clue or idea which will improve the profitability of some phase of the company's operation. The other is the critical consideration of basic accounting concepts as they affect the industry and economy as a whole.

The alert accounting executive has a wealth of opportunity in this area of applied research. All that is needed is the curiosity to ask "why" and "how" and the enthusiasm to seek the answer by studying the raw material at his disposal.

Why is this producing division more profitable than that one? In what area do we find the most oil per dollar spent and what seems to be the reason? Why are maintenance costs so different in refinery *A* as compared to refinery *B?* There are hundreds of such questions which the accounting department should be delving into.

Above all, the supply of new ideas should never run dry. The accounting executive should have the same attitude as his counterpart in the exploration department whose collective industry experience of drilling only one producer out of every nine wildcats does not diminish one bit of his enthusiasm over his current play for a new discovery. This field of applied research offers tremendous potentiality. It gives free rein to imagination and presents real opportunity for the accountant to contribute.

In the area of accounting problems of general industry concern, more research by the petroleum accounting

Rapid industry growth is creating important new uses for oil accounting. Look for increased emphasis in the following general areas:

1. Expansion of accounting research with emphasis on analysis, interpretation and presentation of key information.

2. Increased use of accounting as a means of motivating business actions, not simply recording them.

3. Constant improvement in methods of assembling and classifying data.

4. Broadening of the outlook, education and experience of executive accounting personnel.

There is a growing need to conform accounting techniques with the economic fact that today's prices should be premised on today's finding costs. By adopting the "life" (last in—first out) costing principle in accounting for exploration and development costs, oil companies would benefit in the following ways over the present concept of providing depletion and depreciation on property, plant and equipment:

1. Exploration and development costs would be accounted for on an operating rather than a liquidating basis.

2. The public would be able to see from the income account that higher prices are justified by increased costs.

3. Inflation inherent in current development costs would be absorbed in the income account and not deferred to the future.

4. Accounting for all types of exploration and development costs would be uniform and thus more understandable than the present mixed treatment.

executive and his staff is foreseen. In accounting, as in operating matters, it pays to be ahead or at least abreast of the field in new ideas and techniques. Then too, it is embarrassing to be taken by surprise. A painful example was President Eisenhower's veto of the Harris Bill which was designed to exempt from Federal Power Commission regulation natural gas producers who sell gas for resale in interstate commerce. Those companies whose accounting executives had already shown the foresight to investigate the various theories of allocating producing costs between oil and gas were in a far better position to discuss the problem with operating executives than those who had done little or nothing. Now practically every oil company engaged in production of natural gas is busily trying to develop information on the cost of production.

One basic problem in line for more objective study is how to reflect in the current income account the constant and rapidly increasing cost of finding oil and gas reserves. Many annual reports to stockholders contain apologies in the explanatory text for the shortcomings of the certified statement of income for its failure to reflect current finding costs. The Cost Study Committee of the Independent Petroleum Association of America in its 1955 annual report commented as follows:

"Because of traditional accounting practices, the increasing cost of finding and developing oil to replace that now being produced will not be reflected in the income statements of oil producers for several years to come.

"As in previous reports, this committee urges the industry to take necessary steps to bring about greater recognition of the economic concept of replacement costs in finding, developing, and producing crude petroleum and natural gas. Historic accounting methods of calculating oil producing industry profits result in an overstatement of earnings. The industry's current operations must be planned in the light of present day costs of replacement."

Surely this will arouse the accounting executives of the industry to search for new ideas to solve this problem. One method that should be researched is the extension of the last-in, first-out principle to underground reserves similar to the practice now widely followed for above ground inventories.

As crude oil reserves may be measured with a satisfactory degree of accuracy and as the cost of their discovery and development can be readily identified, it would seem a logical development in accounting theory to treat them as underground inventory. Once this principle has been accepted, adoption of the last-in, first-out method of costing would be the natural second step toward conforming accounting technique to the economic fact that today's prices should be premised on today's finding costs.

The "life" inventory method would function for crude reserves in the same manner recommended by the American Petroleum Institute and used by many companies for above ground inventories. At the date of adoption, the net book value of producing property, plant and equipment would become the amount and the estimated recoverable reserves the quantity of underground inventory. Each year's expenditures for exploration and development, both productive and nonproductive and including the cost of drilling and equipping wells, would represent the cost of reserves discovered that year. Production would be costed and charged to income first from current discoveries and then from opening inventory.

Accounting for exploration and development costs as inventory of underground reserves and using the life costing principle offers the following advantages over the present concept of providing depletion and depreciation on property, plant and equipment.

1. Exploration and development costs would be accounted for on an operating rather than a liquidating basis. The income account would be premised on the same economic concept as the price structure in that current costs would be applied against current income. Low-cost reserves accumulated in prior years would not be drawn upon unless current discoveries dropped below production. When that happened, the company would have, in effect, taken a step toward liquidation, which the accounting technique used would reflect.
2. The public would be able to see

It pays to get this "shopping habit"!

In today's rush of getting everything done yesterday, do you often order operating supplies at the rig? Have you gotten out of the habit of dropping in at the supply store? If so, you may be overlooking the important advantages you gain from careful "in the store" buying.

Continued on next page

Look at it this way—the National Supply Store in your area anticipates your operating needs, stocks only top quality tools, parts, accessories and supplies. Most of these items are displayed in bins, counters and warehouse areas for your personal inspection, comparison and selection. You can *choose* the items that best meet your special needs. You will also find that the National store crew is a virtual encyclopedia of information on equipment ratings, advantages and the kind of performance you can expect from any item.

Occasionally, you may need an unstocked item. They'll order it for you on the spot, make sure it is sent the fastest way possible.

The small amount of time it takes to do "in the store" shopping and *planned* buying can save you money and time—savings you can't make buying at the rig on an emergency order basis. Moreover, you'll be better informed on the newest products available for your use.

Planned National Supply Store buying will give you more on-the-job time and greatly reduce the necessity for emergency orders. Let the National Store personnel near you show you how it really pays to get this "shopping habit."

Rugged, powerful National Rigs pay off in every kind of hole

80 to 1600 horsepower

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What does all of this mean? That National Rigs consistently turn in top level performance on every kind of drilling operation—from shallow, workover or servicing to the world's deepest wells. The widespread use of National Rigs confirms such performance.

This top performance starts with the design and quality manufacture of rigs at National Supply. Years of close association with your drilling problems insure correct, modern design. In manufacturing and assembly, the latest techniques and methods are used. There's great attention to hundreds of construction details—details that can be all-important on a fast drilling schedule. On location, there's service nearby if you need it from the oil country's largest supply company.

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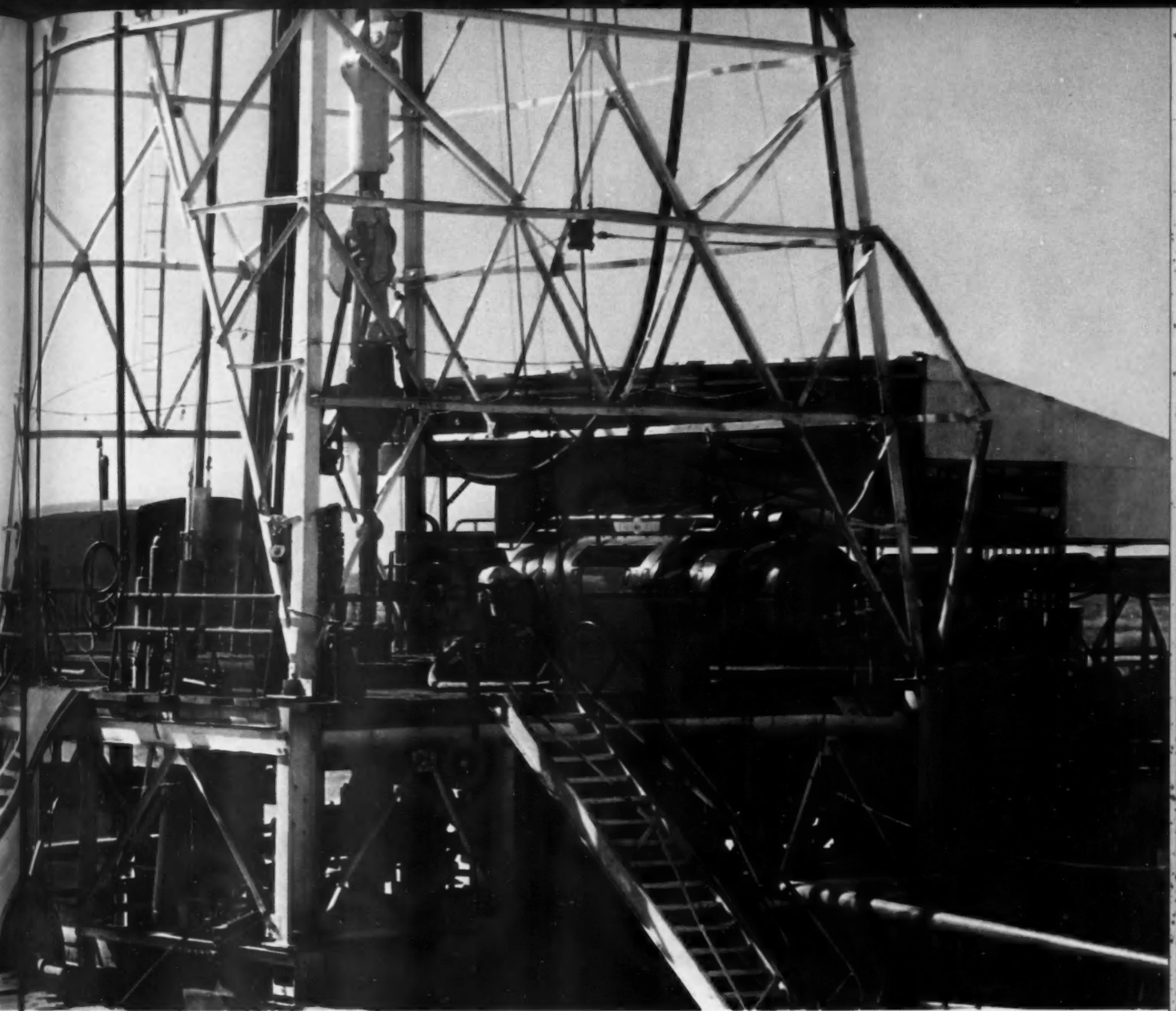
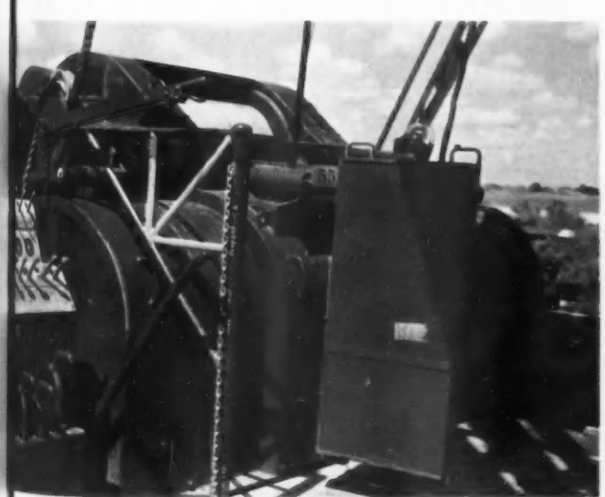
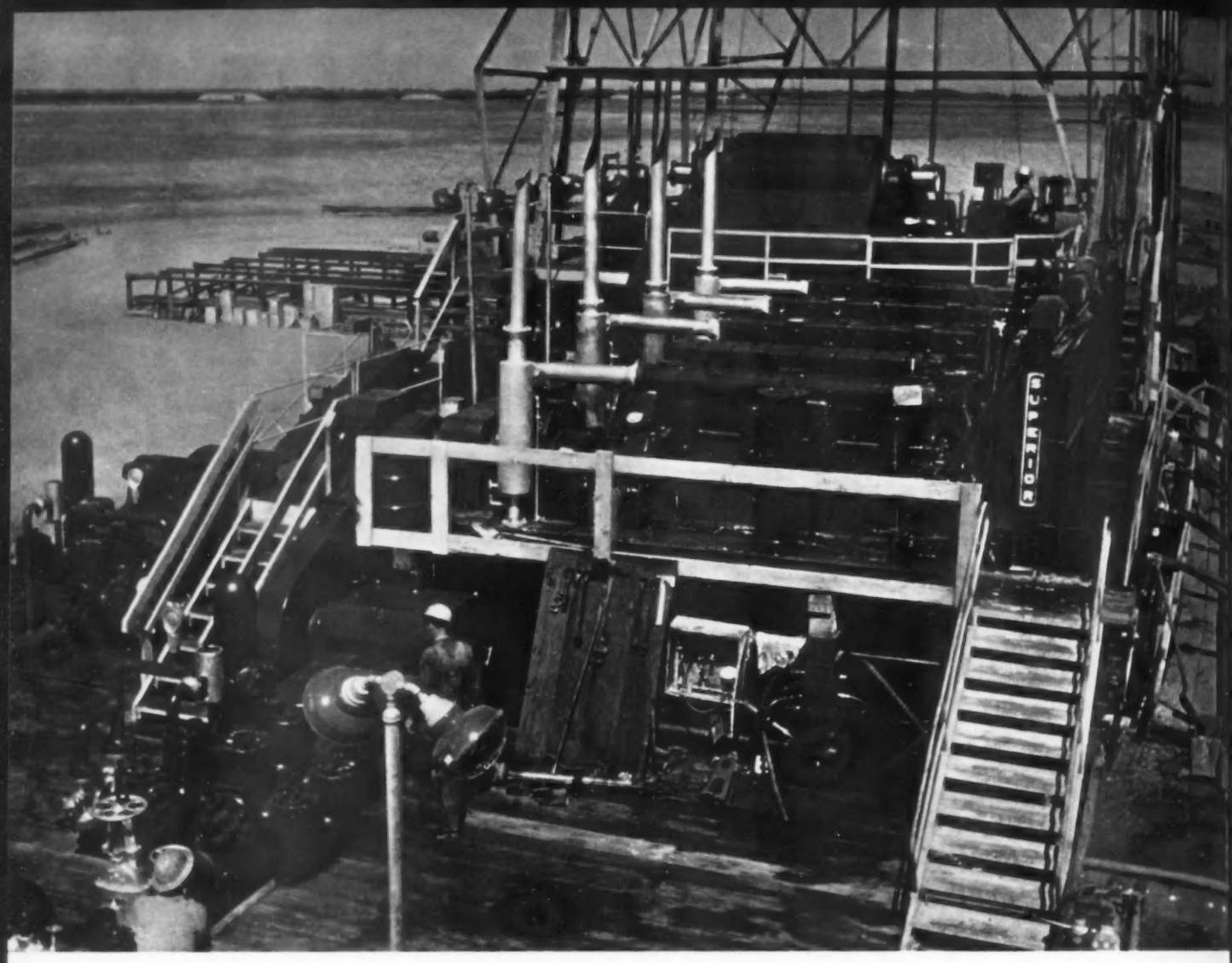
NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT





National's complete line of 10 rigs serves every drilling range—from shallow well, well servicing and workover to the world's deepest wells. For truck or trailer mounted operations, the following National Rigs are available: T-8, T-8-S, T-12, T-12-S, T-20, T-20-S, T-32—in a range of horsepower from 80 to 320. For medium to deep drilling (on land or offshore), these National Rigs are available: Type 55, 80-B, 110, 130, 160—in a range of horsepower from 550 to 2,000. Be sure to ask your local National Supply Store or Representative for complete information and descriptive bulletins on these top performers—proved in service throughout the world.

Want effective power transmission? See next page



Rig up with National Drive Groups for long, low-cost service

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NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT

SPANG STEEL PIPE AND ELECTRICAL CONDUIT

from the income account that higher prices are justified by increased costs.

3. Inflation inherent in current development costs would be absorbed in the income account and not deferred to the future.

4. Accounting for all types of exploration and development costs would be uniform and thus more understandable than the present mixed treatment whereby the several components are variously capitalized and depleted, capitalized and depreciated, expensed immediately, etc.

2. Use of Accounting to Create. The follow-up to effective accounting research is, of course, action. An idea, no matter how brilliant, will not produce results unless it is presented clearly and enthusiastically at the right time and place.

In many instances the attitude and manner of the accounting executive lays the predicate for acceptance or rejection of an idea by his associates in top management. The accountant himself must be convinced that what he has to say is important. He must have abandoned the thought that accounting is solely a service function in the sense that accountants act only upon instruction or request. He must have become imbued with the philosophy that accounting is creative; it can be used to initiate action, to cause the right decisions to be made, rather than merely measuring performance after the fact. Fortunately more and more accounting executives have developed this concept and have by their performance sold it to others in management.

The entire field of budgeting offers a grand opportunity for the accounting executive to develop creative ideas. He assembles departmental estimates of operating income and requests for capital expenditures. He, in effect, has the first look at the overall. By using his imagination, he can experiment with various combinations of assumptions, become intimately familiar with the reasons for each and devise effective presentation techniques to point out the significant strong and weak points. When the budget meeting occurs, planning by the entire executive group is greatly facilitated, decisions may be reached more quickly, and there is far less likelihood that some significant factor will be overlooked.

By using his broad knowledge of his company's affairs as a background for thinking and developing ideas, the accounting executive is truly meriting his presence in the top management group. He is constantly focusing the attention of his associates on troublesome situations before they become problems. He is using accounting to create, to motivate action. In this role, he is making a genuine contribution.

3. Improvement in Methods. The routine, day-to-day work of the accounting department is, of course, the assembling and classifying of data for a myriad of purposes. In this field, the improvement in methods and procedures has been steady and on many occasions dramatic.

When it is realized that the first electronic calculator did not make its appearance until 1946 and that it was not until 1948 that the first practical business adaptation was developed, it will be appreciated that the progress made to date has been truly remarkable. In this connection it should be kept in mind that the initial approach was from a scientific and engineering point of view, rather than for accounting purposes.

The early electronic computers were designed primarily to do mathematical work which calls for relatively low input, complicated calculations, but modest internal memory for storage of data, and few printed outputs. Accounting requirements are almost the reverse since they involve considerable data input, relatively simple calculations in additions and subtraction, a great storage capacity and tremendous output. The oil industry has many illustrations of jobs with these characteristics; two which come to mind are retail credit card sales and crude oil purchases.

The fact that early electronic equipment was designed primarily for scientific purposes has had a delaying effect upon its application to accounting both from adaptability and availability. However, considerable progress has been made during the past few years and today, the larger companies, engaged in the development of electronic equipment, are putting more emphasis on the overall requirement of business.

Careful study of all avenues for improvement in methods will continue to be a major accounting department task. Future progress should be at least as steady as in the past and quite likely will see an acceleration when we acquire greater familiarity with the modern equipment now available is acquired.

4. Broadening of the Outlook. If the accounting executive and his staff are to assume their share of top management responsibility, they must have a broad background of company, industry and human understanding. The best executives are not necessarily the most capable technicians, but rather those highly intelligent individuals who have developed a concern for people and a wide area of interest both within and without their chosen fields. This lesson applies to accounting the same as any other activity.

In the petroleum industry the ambitious young man with a financial education will devote a good deal of his time to acquiring a general knowledge of geology, law, chemistry, marketing, economics, etc. This does not mean, of course, that he will become expert in any one of these fields, but he will gain sufficient familiarity to permit him to carry on an intelligent conversation with specialists in other departments. Greater emphasis will be placed on this phase of training prospective executives in the future.

Quite a number of companies are finding the higher level of accounting supervisors a valuable source of management personnel for operating departments. In many instances these employes are being given the benefits of advanced management courses in colleges and universities. As the accounting executive continues to grow in stature in the top management echelon, it seems logical that there will be an increasing trend toward the use of financially trained personnel for broader responsibilities.

The future offers great challenge and full opportunity for the petroleum accountant. He has earned the respect of top management by his past performance. The growing complexity of business operations assures him an integral part of any administrative scheme. Fortified with the conviction that his work can be creative, he may explore for ideas to the full extent of his imagination and curiosity. With this approach, he is bound to make his share of worthwhile contributions to his company's progress.

—The End

First Quarter Earnings Up 19.2% for 49 Oil Companies

Increases are about the same for international and domestic groups of companies.

By L. J. LOGAN, WORLD OIL Staff

EARNINGS OF the petroleum industry were relatively better than those of most other industries in the first quarter of 1957. Forty-nine oil companies reported combined net income of $921,034,704 for the period. That was $148,552,391 or 19.2 percent more than the $772,482,313 earned by the same companies in the initial quarter of 1956. (See table.)

For U. S. industries in the aggregate, earnings in the first quarter of 1957 were about 8 percent larger than in the like period last year.

An important factor in the relatively good earnings of oil companies in the first quarter was the extraordinary demand for crude oil and products for emergency shipment to Europe. To meet the special European requirements, U. S. oil companies sharply stepped up domestic crude production and also drew down heavily on stocks of crude and fuel oils. State conservation agencies sharply stepped up crude production allowables to a peak in March. Exceptionally large sales of crude and products were made by domestic companies and by the domestic units of the international companies.

While volumes of oils sold were sharply expanded, the prices received for both crude and products also were higher than previously. A general crude price increase, averaging about 30 to 35 cents a barrel, went into effect in early January. Prices of products promptly thereafter were increased proportionately by about 1 cent per gallon.

For the second quarter and the latter half of 1957 the oil companies cannot expect earnings to show the same sharp gain over last year that they did in the first quarter. For in April and May exports to Europe have diminished and crude production allowables have been substantially reduced. Also in April and May salaries and wages of non-union employes in the petroleum industry have been generally increased 5 to 6 percent, and similar increases have been offered to unionized employes. Costs of steel and other goods have further increased this year, and another advance in steel prices is in prospect for mid-year.

Together, the five largest international companies reported 18.6 percent more first quarter profit this year than last year. That was nearly the same as the gain for the industry as a whole. Other companies in the aggregate therefore had a similar improvement in earnings. The internationals had decreases in earnings in the Middle East but compensated for them by increases in Western Hemisphere earnings. —The End

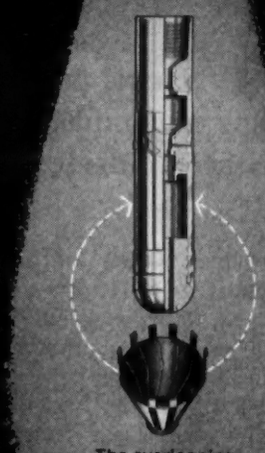
Net Earnings of Some Oil Companies in First Quarter, 1957 and 1956

(All earnings per share are on basis of common shares outstanding March 31, 1957)

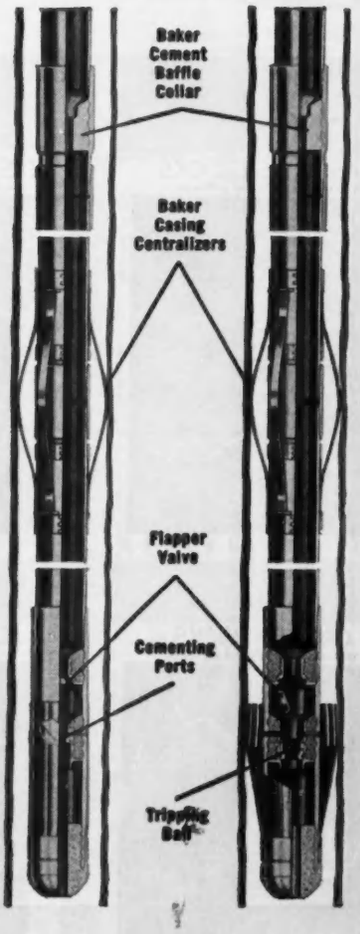
COMPANY	NET INCOME		PER SHARE		% Diff. in Amt. Earned
	1957	1956	1957	1956	
Amerada Petroleum Corporation	$ 8,745,612	$ 7,622,948	$1.39	$1.21	+ 14.7
Anderson-Prichard Oil Corporation	1,483,590	1,352,824	0.84	0.83	+ 9.7
Arkansas Fuel Oil Corporation	2,235,480	1,906,676	0.59	0.50	+ 17.2
Ashland Oil & Refining Company	4,919,275	3,650,925	0.80	0.59	+ 34.7
Associated Oil & Gas Company	251,552	24,261	0.09	0.01	+936.9
Atlantic Refining Company	14,748,584	12,207,514	1.61	1.33	+ 20.8
Aztec Oil & Gas Company	301,345	165,702	0.13	0.07	+ 81.9
Barber Oil Corporation	32,536	305,076	0.04	0.42	— 89.3
Champlin Oil & Refining Company	3,107,105	2,346,000	0.75	0.56	+ 32.4
Cities Service Company	23,426,500	18,179,700	2.27	1.76	+ 28.9
Clark Oil & Refining Corporation	472,166	735,221	0.38	0.59	— 35.8
Colorado Oil & Gas Corporation	690,287	533,045	0.18	0.14	+ 29.5
Continental Oil Company	13,640,000	13,794,000	0.70	0.70	— 1.1
Getty Oil Company	9,305,980	2,333,210	1.59	0.38	+298.8
Gulf Oil Corporation	94,938,000	71,963,000	3.20	2.43	+ 31.9
*Humble Oil & Refining Company	58,200,000	49,300,000	1.62	1.37	+ 18.1
*International Petroleum Company, Ltd	11,100,000	9,300,000	0.77	0.64	+ 19.4
Maracaibo Oil Exploration Corporation	571,569	144,451	1.15	0.29	+295.7
Mississippi River Fuel Corporation	2,022,443	1,829,340	0.57	0.52	+ 10.6
Monterey Oil Company	724,602	705,421	0.20	0.21	+ 2.7
Ohio Oil Company	12,666,008	11,771,336	0.96	0.90	+ 7.6
Phillips Petroleum Company	28,379,430	28,332,238	0.83	0.82	+ 0.2
Plymouth Oil Company	2,519,375	2,283,031	1.02	0.92	+ 10.4
Pure Oil Company	10,170,000	9,184,000	1.18	1.07	+ 10.7
Quaker State Oil Refining Corporation	369,947	525,681	0.45	0.64	— 29.6
Reiter-Foster Oil Corporation	27,064	Loss 70,957	....	....	.....
Richfield Oil Corporation	7,038,861	7,511,559	1.76	1.88	— 6.3
Seaboard Oil Company	3,392,842	2,662,910	0.92	0.73	+ 27.4
Shamrock Oil & Gas Corporation	2,616,134	2,616,958	1.14	1.14	0.0
Shell Oil Company	41,450,000	35,010,000	1.37	1.16	+ 18.4
Signal Oil & Gas Company	3,176,000	2,443,207	0.77	0.60	+ 30.0
Sinclair Oil Corporation	26,302,099	24,245,569	1.72	1.68	+ 8.5
Skelly Oil Company	11,388,255	8,033,062	1.98	1.39	+ 41.8
Socony Mobil Oil Company, Inc	70,000,000	62,000,000	1.53	1.36	+ 12.9
Standard Oil Company of California	69,472,833	61,493,695	1.10	0.97	+ 13.0
Standard Oil Company (Indiana)	45,851,033	41,377,863	1.30	1.17	+ 10.8
Standard Oil Company (Kentucky)	3,283,000	3,005,000	1.26	1.15	+ 9.3
Standard Oil Company (New Jersey)	237,000,000	205,000,000	1.20	1.04	+ 15.6
Standard Oil Company (Ohio)	7,841,290	6,517,232	1.59	1.35	+ 20.3
Sun Oil Company	13,331,110	12,255,231	1.24	1.14	+ 8.8
Sunray Mid-Continent Oil Company	16,296,620	11,385,031	0.89	0.60	+ 43.1
The Texas Company	86,424,269	69,958,343	1.57	1.27	+ 23.5
Texas Pacific Coal & Oil Company	2,068,125	2,054,916	0.57	0.57	+ 0.6
Texas Gulf Producing Company	1,879,000	1,797,493	0.48	0.46	+ 4.5
Tidewater Oil Company	11,335,000	9,037,000	0.88	0.69	+ 25.4
Union Oil Company of California	9,327,132	7,030,225	1.21	0.91	+ 32.7
United Gas Corporation	11,517,683	9,616,293	0.89	0.74	+ 19.8
Universal Consolidated Oil Company	981,151	898,287	1.02	0.93	+ 9.2
Venezuelan Petroleum Company	2,209,637	2,276,330	0.55	0.56	— 2.9
Wilcox Oil Company	253,838	299,719	0.89	1.06	— 15.3
Woodley Petroleum Company	850,342	501,747	1.08	0.64	+ 69.5
*Total, 49 Companies	921,034,704	772,482,313	....	....	+ 19.2

* Humble and International Petroleum are excluded from totals, being included as affiliates of Standard (N.J.)

Protect permeable low pressure zones with the BAKER TRIPLEX cementing shoe...



The overlapping Petals form a strong, tight bridge to prevent downward movement of slurry.



Cementing casing at a predetermined point above bottom, and at the same time protecting a lower, permeable zone from cement contamination always has been a difficult problem. Such work is now a routine operation with a Baker TRIPLEX Cementing Shoe.

A special float shoe is combined with a Baker Metal Petal Basket that expands to form a bridge and retain cement slurry above the Basket, even in large-diameter or irregularly shaped holes. The TRIPLEX Shoe, with its flapper-type back-pressure valve, operates as a conventional float shoe while landing the casing and conditioning the hole. When cementing is done and pump pressure is stopped, the valve closes and cement is held in place behind the casing until it sets.

Baker Casing Centralizers are installed on (and above) the shoe joint, thus providing a uniform annulus to receive the slurry. While running-in, a Hold-Down Strap (secured by shear screws) retains the Basket against the TRIPLEX Shoe, and the cementing ports are covered by the Tripping Valve. After reaching the desired point, a Tripping Ball is dropped to seat upon the Tripping Valve. Pressure is applied to shear the screws, force the Tripping Valve downward, and expose the cementing ports. This action releases the Hold-Down Strap and the Basket expands against the walls of the hole. When cementing starts, the slurry is directed upward by Baker "Whirling" Action, and retained above the shoe by the Metal Petal Basket.

BAKER OIL TOOLS, INC., HOUSTON • LOS ANGELES • NEW YORK

World Changes Follow Suez Crisis

U. S. cuts production, plans more imports, as Mid-East oil flow expands. New pipe line and tankers will cut dependence on Suez. More firms join Western Hemisphere oil search outside U. S.

Following the Suez Crisis and to some extent because of it, the oil industry currently is going through a readjustment of worldwide ramifications and significance.

The movement of Middle East oil to Europe is being stepped up. Emergency shipments of crude and fuel oils from the U. S. and the Caribbean area to Europe are being replaced by the Middle East oils.

State oil conservation agencies in the U. S. have further reduced crude production allowables for June, following the earlier cuts of April and May. The allowable reductions have been accentuated by seasonal lagging of demand for fuel oils and some other products.

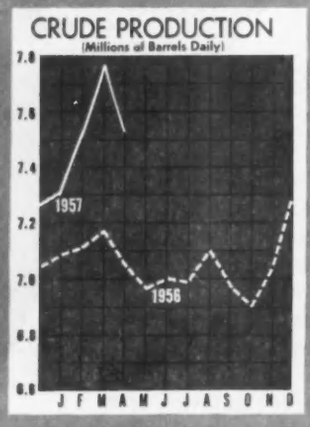
The stage has been set for resumption of imports of Middle East crudes into the U. S. in substantial volumes. Domestic producers again are asserting that the threat of excessive imports is serious.

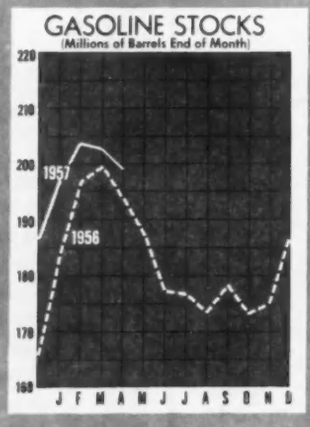
The Caribbean region, like the U. S., experienced abnormal demand for its oils in the wake of the Suez Canal closure. Increased volumes were sent to the U. S. to compensate for emergency export of U. S. oils to Europe. Now the abnormal demand for Venezuelan and other Caribbean oils is disminishing.

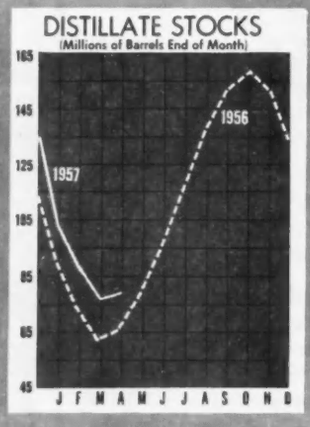
While the Suez crisis has led to the current worldwide readjustments of supply and demand, it also has resulted in long range planning that will bring further, far reaching readjustments.

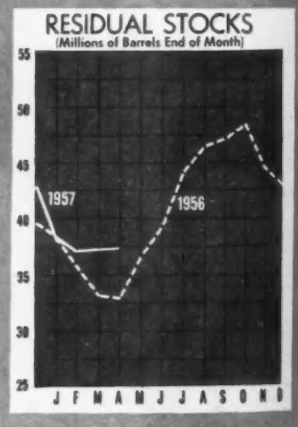
The latest highly significant development in this planning for the future is the firming up of the proposal of a huge new pipe line from the Persian Gulf oil fields to a port in Turkey or some other country on the Mediterranean. Planning of such a line recently was advanced materially at conferences in London. It would be built and used jointly by most of the American, British, and French com-

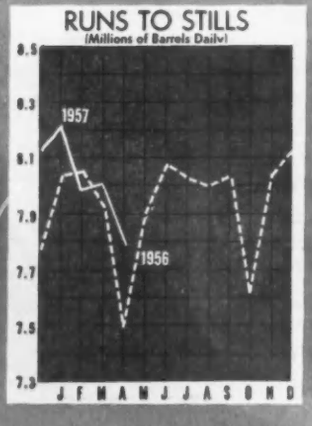
Petroleum Trends . . .

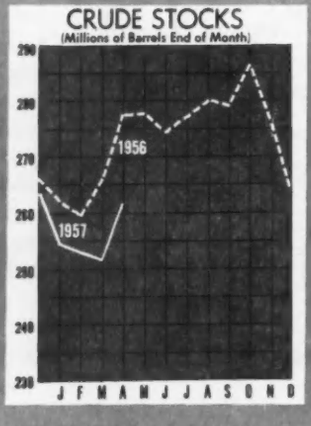


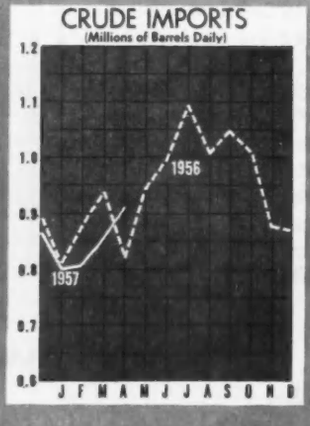


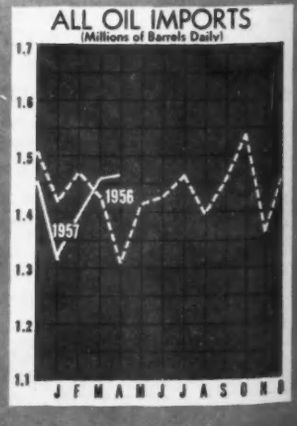












panies producing oil in the Middle East. The line could carry well over 1 million barrels of oil per day. It would supplement shipments by tanker, including those through the Suez Canal.

Also involved in the long range planning following the Suez crisis is the active worldwide tanker construction program. Shipyards are booked up with orders for new tankers for several years ahead.

Among the new tankers will be a liberal supply of the "Supers," affording greater capacities than ever before. Because of their size and speed, they are expected to be able to carry oil from the Persian Gulf to the U. S. and to Western Europe via the Cape of Good Hope in competition with oils going through the Suez Canal and pipe lines and thence through the Mediterranean. The big tankers also will add flexibility to world oil movements and will serve as some insurance against disruption of oil movements by other means and over other routes.

Finally, the Suez crisis has emphasized the danger of depending too heavily on oil in the Middle East or in any other single region. The canal closure has caused oil companies throughout the world to take increased interest in oil exploration and development in other regions, particularly the Western Hemisphere.

For U. S. oil companies, Canada, Venezuela, Cuba, Bolivia, and other Central and South American countries have become increasingly attractive as places to search for oil. Furthermore, the interest is no longer confined to a few international companies or even to the major companies. Even some smaller companies and independent operators are entering or thinking of entering development in countries outside the U. S. Venezuela in 1956 and 1957 has sold concessions to a long list of newcomers from the U. S.

Both the current world oil market readjustments and the increased movement of U. S. operators into other countries are having repercussions in U. S. operations. Production, exploration, and drilling within the U. S. currently are all being slowed somewhat by the international developments. Money being spent by U. S. companies in other countries cannot be spent also on U. S. development.

The petroleum industry has become increasingly international in scope, and the U. S. segment is becoming increasingly susceptible to world developments. The current situation points up the necessity of action on U. S. oil imports.

U. S. Crude Production by States

(THOUSANDS OF BARRELS)

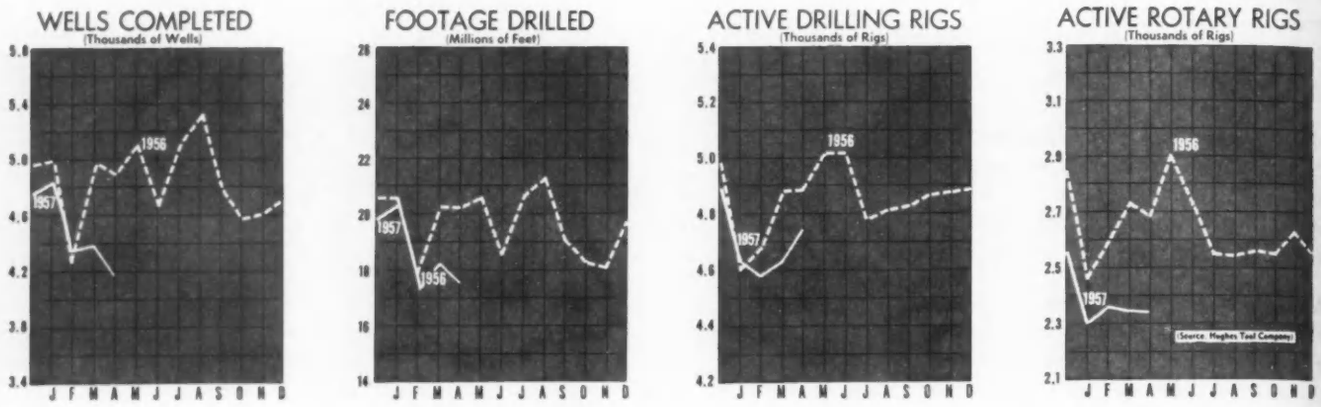
STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION FIRST FOUR MONTHS		
	April, 1957	March, 1957	April, 1956	% Diff. 1957-1956	1957	1956	% Diff. 1957-1956
Alabama	11.8	11.7	4.8	+145.8	1,401	666	+110.4
Arkansas	83.9	83.7	73.0	+ 14.9	10,214	9,365	+ 9.1
California	928.8	936.8	964.8	— 3.7	112,323	117,136	— 4.1
Colorado	156.1	158.5	165.0	— 5.4	18,959	19,440	— 2.5
Florida	1.3	1.3	1.4	— 7.1	150	165	— 9.1
Illinois	228.1	229.5	230.2	— 0.9	27,115	27,284	— 0.6
Indiana	32.1	32.4	31.6	+ 1.6	4,124	3,372	+ 22.3
Kansas	333.3	345.9	335.1	— 0.5	40,448	41,371	— 2.2
Kentucky	47.4	48.8	47.4	.....	5,689	5,788	— 1.7
Louisiana	953.0	1,013.5	826.0	+ 15.4	119,637	98,113	+ 21.9
North Louisiana	132.2	132.5	120.9	+ 9.3	16,376	15,325	+ 6.9
South Louisiana	820.8	881.0	705.1	+ 16.4	103,261	82,788	+ 24.7
Michigan	26.9	27.6	28.8	— 6.6	3,358	3,721	— 9.8
Mississippi	115.0	114.2	111.8	+ 2.9	13,760	13,432	+ 2.4
Missouri	0.2	0.1	0.2	.....	18	19	— 5.3
Montana	71.9	72.2	53.7	+ 33.9	8,503	6,747	+ 26.0
Nebraska	49.4	38.3	38.5	+ 28.3	5,544	4,953	+ 11.9
Nevada	0.1	0.1	0.3	— 66.7	12	25	— 52.0
New Mexico	273.0	268.1	249.6	+ 9.4	31,902	29,145	+ 9.5
Southeast New Mexico	270.0	265.5	248.1	+ 8.8	31,401	28,745	+ 9.2
Northwest New Mexico	3.0	2.6	1.5	+100.0	501	400	+ 25.3
New York	7.7	7.7	10.1	— 23.8	899	904	— 0.6
North Dakota	29.1	39.2	26.7	+ 9.0	4,500	4,601	— 2.2
Ohio	14.0	13.8	13.0	+ 7.7	1,640	1,511	+ 8.5
Oklahoma	629.5	674.2	600.9	+ 4.8	76,825	73,883	+ 4.0
Pennsylvania	23.2	22.8	18.9	+ 22.8	2,745	2,638	+ 2.5
South Dakota	0.1	0.1	0.1	.....	8	8	.....
Tennessee	0.1	0.1	0.1	.....	6	6	.....
Texas	3,207.6	3,324.4	3,029.7	+ 5.9	386,352	372,018	+ 3.9
Dist. 1: South Central	56.6	57.4	55.0	+ 2.9	6,795	6,394	+ 6.3
Dist. 2: Middle Gulf	163.4	172.2	159.7	+ 2.3	19,529	19,377	+ 0.8
Dist. 3: Upper Gulf	472.1	485.4	452.8	+ 4.3	56,325	55,309	+ 1.8
Dist. 4: Lower Gulf	250.3	258.9	248.6	+ 0.7	29,727	30,251	— 1.7
Dist. 5: East Central	42.5	44.2	45.5	— 6.6	5,068	5,638	— 10.1
Dist. 6: Northeast	357.5	380.8	345.9	+ 3.4	43,210	42,889	+ 0.7
Dist. 7-B: North Central	168.3	172.7	160.5	+ 4.9	20,046	19,045	+ 5.3
Dist. 7-C: West Central	174.4	179.4	192.9	— 9.6	21,004	22,119	— 5.1
Dist. 8: West	1,197.7	1,251.2	1,060.2	+ 13.0	142,583	126,270	+ 12.9
Dist. 9: North	215.3	216.6	213.5	+ 0.8	25,622	25,099	+ 2.1
Dist. 10: Panhandle	109.7	105.6	95.1	+ 15.4	12,468	11,330	+ 10.0
Utah	11.8	12.9	4.9	+140.8	1,375	633	+117.2
Virginia	0.1	0.1	0.1	.....	7	3	+133.3
West Virginia	6.1	6.2	5.9	+ 3.4	723	717	+ 0.8
Wyoming	283.8	300.2	271.0	+ 4.7	35,817	34,534	+ 3.7
Total United States	7,525.0	7,784.4	7,143.6	+ 5.3	914,054	872,198	+ 4.8

U. S. Crude Oil and Refined Product Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1955:											
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	1,981	133,981	1,288	44,491	873	1,471
1957:											
January	7,480	8,274	256,669	3,991	197,702	2,118	100,572	1,322	38,403	805	1,421
February	7,682	8,088	256,344	3,864	205,270	2,035	85,105	1,270	31,201	780	1,430
March	7,784	8,042	252,313	3,704	203,412	1,856	75,615	1,219	37,311	860	1,457
April	7,384	7,525	261,505	3,743	198,872	1,757	77,913	1,164	37,350	903	1,462
Week Ended:											
5-10-57	7,434	8,050	261,876	3,717	197,402	1,824	82,260	1,196	38,571	807	1,286
5-11-56	7,029	7,911	273,606	3,772	187,708	1,637	64,945	1,178	33,119	899	1,289

Drilling Activities . . .



Year's Wells Still Trail, As Rigs Continue to Climb

By CECIL W. SMITH, WORLD OIL Staff

U. S. DRILLING activity made some comeback during April, but the number of wells completed failed to match those of the previous month. At the end of the month, drilling rigs totaled 128 more than were in the field at the close of March, but the results had not yet showed up in completed wells statistics.

New wells completed during April totaled 4147, against 4382 in March and 4855 recorded in April of last year. This dropped the year's four-months total to a deficit of 7 percent compared with the 1956 record. A month earlier, wells trailed the previous year by only 5 percent.

Some encouragement can come from the fact that at the end of April there were 4749 drilling rigs active in the nation, and that was a gain of almost 3 percent over the 4621 counted a month earlier. Resulting wells should soon start narrowing the difference between the two years' records. Despite the fact that this difference now amounts to 7.2 percent in favor of 1956, the difference in the number of operating rigs is now slightly less than 3 percent lower than it was at the same time last year.

In the first four months of 1957, the average well was drilled to a depth of 4157 feet, while in the same period of last year average depth calculated 4123 feet. This of course points to a little better comparison between the two years in the matter of footage drilled. The 73⅓ million feet of hole recorded in the first-quarter this year trailed the 78⅓ million in 1956 by 6.5 percent, against the 7.2 percent drop in the number of wells.

Usually Texas sets the pace for the nation in drilling rates. However, the rest of the country has not matched the stride so far this year. In the first-quarter, a total of 7674 wells was completed in Texas. That represented a gain of 125 wells, or 1.7 percent, over the 7549 drilled in 1956's comparable period. However, the hike has not been completely state-wide. West Texas has been the principal front-runner, with the northern sector following. The coastal plains, generally, have not kept the pace.

Healthy gains have been made also in New Mexico, Arkansas and in Louisiana's offshore region. Recent weeks have seen the number of rigs increase in these same areas indicating that their activity will continue to be high.

Most of the other leading drilling states have experienced lowered activity so far this period. Oklahoma, with 2085 new wells to its credit is still 25 percent behind year-ago level. However, more rigs are being put to work there. Operations have lagged 9 percent in Kansas, but there also rigs are building up in numbers. Trailing last year by almost 30 percent is Illinois, and rigs have declined since the first of the year. California's operations have been only slightly under the 1956 rate and are showing signs of stepping up.

Summary of U. S. Drilling Activity

ITEM	April, 1957	Mar., 1957	FOUR MONTHS January-April 1957	1956	Percent Diff.
New Wells Completed:					
Oil	2,221	2,303	9,515	10,291	— 7.6
Distillate	66	61	220	191	+ 15.2
Gas	251	313	1,145	1,252	— 8.6
Service	87	72	321	287	+ 11.8
Dry	1,522	1,633	6,439	6,988	— 7.9
Total Wells	4,147	4,382	17,640	19,009	— 7.2
Footage Drilled (Mln. of Feet)	17.4	18.2	73.3	78.4	— 6.5

Details on Page 118

Summary of U. S. Wildcat Drilling

ITEM	April, 1957	Mar., 1957	FOUR MONTHS January-April 1957	1956	Percent Dif.
New Field Discoveries:					
Oil	49	54	264	337	— 22.7
Distillate	10	11	45	37	+ 21.6
Gas	19	16	76	68	+ 11.8
Total Discoveries	78	81	385	442	— 12.9
Dry Wildcats	781	823	3,310	3,459	— 4.3
Total Wildcats	859	904	3,695	3,901	— 5.3
Percent Productive	9.1	9.0	10.4	11.3	.....
Percent Dry	90.9	91.0	89.6	88.7	.....

Details on Page 118

Squeezing Burns Up Profits!

The Weatherford Technique helps you avoid squeeze jobs.

Everyone knows that squeeze cementing is costly—both in dollars spent and production time lost. The cost can never be recovered even if the squeeze is successful.

Squeezing can be avoided, however, by securing a good cement job the first time. The Weatherford Technique is the best known method of obtaining a good primary cement job. Considering the major investment required in drilling the well down to the casing point, The Weatherford Technique is mighty low cost insurance.

The Weatherford Technique helps prevent cement channeling and the formation of water voids, by controlling the excess water used in today's cement slurries.

It helps prevent bridging and so-called flash setting, by controlling the floculated mass of mixed mud and cement.

It helps insure a known annulus for the passage of mud and cement all around the casing, through the use of properly spaced centralizers of the correct size and type.

It helps insure a strong bond between cement and formation, by removal of excess wall cake, gelled or viscous mud, and other foreign matter.

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THE WEATHERFORD TECHNIQUE

U. S. Drilling Activity in April and First Four Months, 1957-1956

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED — DETAILS FOR APRIL, 1957					TOTAL NEW WELLS			Total Footage April, 1957	DETAILS FOR JANUARY-APRIL — NEW WELLS			DETAILS FOR JANUARY-APRIL — FOOTAGE		WILDCAT DRILLING IN APRIL AND FIRST FOUR MONTHS, 1957-1956 — DETAILS FOR APRIL, 1957					DETAILS FOR JANUARY-APRIL					DRILLING RIGS IN OPERATION		
	Oil	Dist.	Gas	Dry	Service Wells	April, 1957	Mar., 1957	April, 1956		1957	1956	Percent Diff.	1957	1956	Oil	Dist.	Gas	Dry	Total Wildcats	Oil	Dist.	Gas	Dry	TOTAL WILDCATS 1957	TOTAL WILDCATS 1956	April 30, 1957	Mar. 31, 1957	April 30, 1956
Alabama	9	....	....	2	....	11	13	7	116,290	41	24	+ 70.8	374,577	206,702	....	....	....	2	2	....	....	1	12	13	7	17	15	14
Arizona	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	1	....
Arkansas	50	....	2	16	....	68	71	76	211,288	321	271	+ 18.5	901,692	884,635	....	....	....	9	9	1	....	....	38	39	44	70	69	48
California	115	....	2	54	....	171	181	177	635,281	704	726	— 3.0	3,052,268	3,408,710	1	....	....	31	32	5	....	2	115	122	190	192	176	223
Colorado	8	....	6	39	....	53	61	93	276,465	274	433	— 36.7	1,410,869	2,327,105	2	....	2	29	33	6	....	5	155	166	199	51	50	59
Florida	....	....	....	1	....	1	3	....	6,920	6	6	....	40,312	35,002	....	....	....	1	1	....	....	....	6	6	6	1	1	....
Georgia	....	....	....	2	....	2	....	1	11,530	3	1	+200.0	18,955	3,550	....	....	....	2	2	....	....	....	3	3	1	....	2	2
Idaho	....	....	....	....	....	....	....	....	....	1	1	....	3,947	4,528	....	....	....	....	....	....	....	....	1	1	1	....	....	....
Illinois	64	....	2	111	....	177	188	318	404,083	747	1,063	— 29.7	1,698,181	2,510,046	....	....	....	49	49	5	....	1	208	214	269	212	207	265
Indiana	13	....	2	18	....	33	48	42	47,225	192	180	+ 6.7	297,418	311,438	....	....	....	10	10	1	....	....	53	54	47	105	100	84
Kansas	130	....	26	129	7	292	334	392	1,039,510	1,349	1,482	— 9.0	4,795,359	5,405,847	2	....	4	55	61	31	....	11	253	295	387	524	496	455
Kentucky	41	....	16	58	....	115	116	150	170,871	435	568	— 23.4	686,898	800,162	1	....	....	15	16	4	....	....	24	28	46	129	111	121
Louisiana	160	21	14	106	....	301	285	304	2,461,718	1,146	1,142	+ 0.4	9,684,479	8,760,716	....	4	1	41	46	10	18	5	157	190	182	399	420	437
North Louisiana	51	1	5	32	....	89	82	135	310,300	408	413	— 1.2	1,462,406	1,544,471	....	....	1	7	8	1	1	1	41	44	52	75	72	77
South Louisiana	109	20	9	74	....	212	203	169	2,151,418	738	729	+ 1.2	8,222,073	7,216,245	....	4	....	34	38	9	17	4	116	146	130	324	348	360
* Gulf of Mexico	41	2	1	17	....	61	59	36	551,956	213	151	+ 41.1	2,001,819	1,380,723	....	....	....	6	6	4	4	1	20	29	21	97	96	68
Maryland	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Michigan	12	....	....	16	....	28	33	24	65,075	124	156	— 20.5	358,715	433,872	....	....	....	12	12	4	....	....	52	56	50	77	65	58
Mississippi	9	1	....	25	....	35	31	40	249,201	123	145	— 15.2	860,729	1,074,158	....	....	....	16	16	4	....	....	52	56	56	34	39	29
Missouri	....	....	....	....	....	....	....	1	....	....	15	—100.0	....	13,595	....	....	....	....	....	....	....	....	1	1	9	....	....	....
Montana	15	....	....	16	....	31	24	24	167,338	104	129	— 19.4	597,018	698,024	1	....	....	9	10	2	....	1	29	32	41	35	37	47
Nebraska	18	....	....	37	....	55	65	87	327,052	254	328	— 22.6	1,514,740	1,866,562	2	....	....	28	30	13	....	....	118	131	164	41	36	45
Nevada	....	....	....	2	....	2	....	1	2,332	3	2	+ 50.0	5,718	17,403	....	....	....	2	2	....	....	....	3	3	....	1	2	4
New Mexico	91	2	41	36	....	170	158	166	745,682	744	605	+ 23.0	3,315,698	2,785,543	3	....	....	16	19	16	....	2	84	102	73	160	150	203
New York	20	....	3	3	13	39	39	33	66,400	153	114	+ 34.2	261,300	162,400	....	....	....	....	....	....	....	....	....	....	....	50	52	52
North Dakota	11	....	....	8	....	19	22	25	135,460	92	94	— 2.1	626,805	717,127	3	....	....	8	11	5	....	....	36	41	26	24	22	20
Ohio	45	....	13	14	....	72	76	94	180,179	301	346	— 13.0	750,965	864,090	....	....	....	....	....	....	....	....	3	3	2	214	208	218
Oklahoma	278	4	13	145	15	455	499	690	1,903,380	2,085	2,790	— 25.3	7,595,415	10,104,163	5	1	2	43	51	23	5	8	197	233	292	604	575	644
Oregon	....	....	....	....	....	....	....	....	....	....	1	—100.0	....	12,880	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Pennsylvania	23	....	24	6	23	76	78	58	220,042	297	250	+ 18.8	849,916	704,799	....	....	3	....	3	....	....	11	6	17	....	171	165	142
South Dakota	....	....	....	7	....	7	5	2	15,613	18	3	+500.0	61,961	19,542	....	....	....	6	6	....	....	....	17	17	3	2	3	4
Texas	1,060	38	69	636	29	1,832	1,927	1,938	7,524,215	7,674	7,549	+ 1.7	31,822,547	31,922,897	26	5	6	382	419	125	22	22	1,605	1,774	1,789	1,349	1,338	1,439
Dist. 1: South Central	72	....	3	49	....	124	144	173	263,175	507	678	— 25.2	1,276,378	1,866,560	....	....	....	26	26	6	1	....	134	141	195	43	51	71
Dist. 2: Middle Gulf	13	5	5	22	....	45	58	81	286,963	226	302	— 25.2	1,451,277	1,856,025	1	1	....	15	17	1	4	5	65	75	86	44	43	57
Dist. 3: Upper Gulf	70	11	5	66	....	152	138	172	1,015,356	603	611	— 1.3	4,145,426	4,015,784	1	1	....	44	46	7	6	1	157	171	161	128	136	157
* Gulf of Mexico	....	....	....	1	....	1	....	....	6,502	5	4	+ 25.0	37,935	40,088	....	....	....	....	....	1	....	....	2	3	2	....	1	1
Dist. 4: Lower Gulf-S.W.	39	18	16	55	....	128	121	118	720,564	472	465	+ 1.5	2,518,086	2,407,584	2	1	....	42	45	8	3	1	143	155	143	71	85	77
* Gulf of Mexico	....	2	....	....	....	2	2	1	18,457	7	4	+ 75.0	68,540	40,226	....	....	....	....	....	....	....	....	....	....	....	1	4	3
Dist. 5: East Central	....	1	....	7	....	8	23	23	33,345	60	90	— 33.3	287,852	292,496	....	....	....	6	6	1	1	....	41	43	44	4	5	8
Dist. 6: Northeast	54	1	3	26	....	84	102	85	446,903	375	295	+ 27.1	2,039,128	1,526,756	....	....	....	17	17	1	....	2	83	86	88	70	71	73
Dist. 7-B: North Central	116	....	2	126	1	245	234	278	828,340	940	1,118	— 15.9	3,152,074	3,838,268	7	....	1	82	90	35	....	3	291	329	408	121	128	156
Dist. 7-C: West Central	50	....	3	27	....	80	84	111	321,535	422	434	— 2.8	1,846,236	2,010,039	3	....	1	22	26	15	....	3	113	131	98	97	95	120
Dist. 8: West	333	1	5	74	5	418	427	352	2,080,227	1,719	1,355	+ 26.9	8,457,304	7,039,119	5	1	....	43	49	21	1	2	152	176	174	390	378	339
Dist. 9: North	230	....	9	174	23	436	464	449	1,114,136	1,872	1,794	+ 4.3	4,789,670	5,527,691	7	....	3	81	91	25	....	3	401	429	355	246	232	270
Dist. 10: Panhandle	83	1	18	10	....	112	132	96	413,671	478	407	+ 17.4	1,859,116	1,542,575	....	1	1	4	6	5	6	2	25	38	37	135	114	111
Utah	7	....	....	5	....	12	21	6	65,765	49	43	+ 14.0	290,720	199,939	1	....	....	5	6	3	....	1	23	27	34	40	36	16
Washington	....	....	....	....	....	....	1	....	....	1	1	....	5,980	7,493	....	....	....	....	....	....	....	....	1	1	1	....	....	....
West Virginia	13	....	14	9	....	36	57	38	98,862	183	232	— 21.1	501,909	620,365	....	....	....	....	....	....	....	4	2	6	....	165	180	170
Wyoming	29	....	4	21	....	54	46	68	243,723	216	309	— 30.1	943,113	1,499,183	2	....	1	10	13	6	....	2	56	64	81	80	65	84
Total United States	2,221	66	251	1,522	87	4,147	4,382	4,855	17,391,500	17,640	19,009	— 7.2	73,328,204	78,373,476	49	10	19	781	859	264	45	76	3,310	3,695	3,901	4,749	4,621	4,886
Total Western Canada	172	....	21	76	4	273	304	171	1,336,575	1,050	811	+ 29.5	4,953,381	3,920,301	....	....	....	....	....	....	....	....	....	....	....	195	223	159

* Gulf of Mexico wells are included in their respective district totals.

we can show you the forest because of the trees

Many times oil men feel they are in a poor position financially simply because they can't see the entire picture of their operations. Caught in the complexities of their day-to-day activities, they are unable to survey their properties in a realistic, objective manner. And as a result, many times they end up working for their creditors.

Increased operating costs spell falling profits. And that means trouble. While there is no short cut way out of this problem, The Commerce working with your legal and tax counsel can many times show you how to increase profit by reducing costs. Tighter managerial control, an analysis of costs, and recommendations for changes have increased the profit of other oil men. If your problems are similar, come to the bank that actually does know the oil business and that can help you.

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What's Ahead in the Permian Basin

Projected oil and gas lines to provide new markets for producers . . . operators will increase drilling to meet greater demand

By L. J. LOGAN
WORLD OIL Staff

VIGOROUS EXPLORATION and field development are in store for the Permian Basin of West Texas and Southeast New Mexico. Plans are being pushed for large expansion of pipe line outlets for both crude oil and natural gas. The proposed pipe line construction will encourage companies and operators to enlarge their exploratory and field developments.

Operators foresee good demand for their oil and gas. They will conduct active drilling programs. There are many proved and semi-proved locations to be drilled in the vast region.

An uninterrupted growth of drilling for several years or more can be expected if markets and pipe line facilities continue to expand.

More Market Outlet Planned. The Permian Basin already has pipe line outlet for 2 million barrels of crude oil per day. In March of this year, at the height of the emergency demand for oil for Europe, the pipe lines actually moved slightly over 1.7 million barrels per day from the Basin.

That volume was virtually the same as the Basin's production of 1,700,000 barrels per day during March. Texas Railroad Commission District 8 of West Texas produced 1,255,000 barrels daily, District 7-C of West Central Texas yielded 180,000 daily, and Southeast New Mexico 265,000 a day.

Upon completion of presently planned new lines, the total pipe line capacity from the Permian Basin will be increased to approximately 2½ million barrels per day.

"Super" Line To Be Built. A new "super" crude oil pipe line is projected from the Midland sector of the Permian Basin to the Houston refinery and trunk line terminal area. Also scheduled is the addition of 75,000 barrels per day of capacity to the Magnolia Pipe Line Company system from Midland to the Beaumont refining and shipping area.

Seven major producers, transporters, and purchasers of crude are supporting the proposed new 26-inch Midland-Houston carrier, which is slated to have a capacity of between 400,000 and 500,000 barrels daily. Progress on that project is being delayed by difficulty in obtaining the large diameter pipe required. Steel mill schedules will not permit completion of the line until 1960. The seven pipe line companies interested in the "jumbo" line include: Atlantic, Cities Service, Continental, Gulf, Phillips, Sinclair, and Texas. Industry Pipe Line Company is the proposed name of the company to be formed to build and operate the big line.

Magnolia originally was also considering participation in the "super" line. But in order to gain needed capacity more promptly, Magnolia decided to expand its own existing system, for which smaller pipe involved was more readily available.

The Magnolia project will involve filling in loops and adding pumping equipment. Adding 75,000 barrels, this expansion will boost the capacity of Magnolia's Midland-Beaumont line to 235,000 barrels daily. Contracts have been let. Construction will start in August, 1957. The project is scheduled to be completed in the first quarter of 1958.

The proposed expansion of transportation facilities provides confidence that accelerated drilling will be adequately supported.

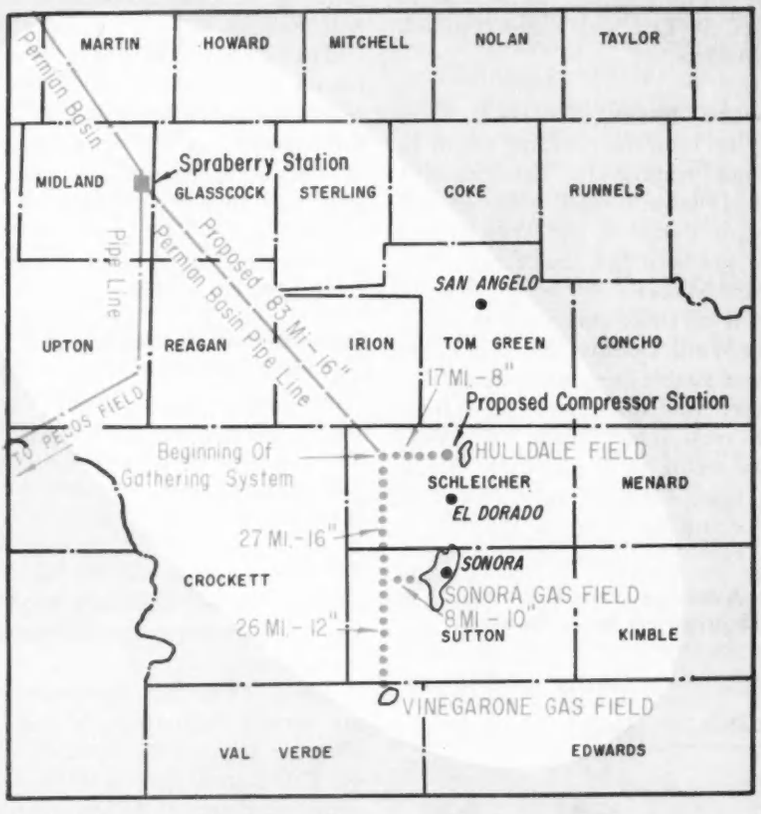
The need for additional pipe line capacity from the Permian Basin was emphasized during the stoppage of the Suez Canal, when extra crude from the area could not be readily laid down at tidewater for shipment to Europe.

Some Unused Capacity Now. However, there is currently a substantial volume of pipe line capacity leading from the Permian Basin which is not being utilized. It is already available and could be used if more urgently needed.

The present idleness of some capacity is due to various factors. The capacity is unused primarily because the owners do not desire to step up their oil purchases in the region while crude of more desirable price or quality is available elsewhere for their refineries. Imports are a big factor, holding down the demand for Permian Basin crude. Refineries in the Middle West are absorbing greater amounts of crude from the Rocky Mountain territory.

Table 1 shows the capacity of main pipe lines from West Texas and Southeast New Mexico and the daily average oil movement through them for the month of March, 1957.

New Pipe Lines Will Encourage Basin Gas Development



Permian Basin natural gas development will be generally stimulated as market outlets for gas wells are provided.

New gas fields of three West Texas counties are due to gain market outlets, as shown here.

Permian Basin Pipe Line Compny has applied for authority to extend its system into Schleicher, Sutton, and Val Verde Counties.

El Paso Natural Gas Company plans to build a 20-inch gas line to Hobbs, New Mexico, from the Sonora field, Sutton County, where it has been developing gas production.

At first glance the tabulation is misleading as to unused capacity. It must be considered that some of the idle capacity out of the Basin is utilized "down the line" by picking up loads in West Central and North Texas.

Also, some capacity is unfavorably located for participating in the current movement of Permian Basin crudes to market. Examples include the Phillips line to the Borger area of the Texas Panhandle, Service's carrier to Drumright, Okla., and Shell's line to Cushing, Okla. Those three "wrong way" lines alone have combined unused capacity of 75,000 barrels per day. In contrast, several trunk lines direct to the coast at Corpus Christi, Houston and Beaumont have been operating at full capacity.

Since March will stand as a high water mark in allowables, it can be figured that pipe line runs will be somewhat lower in daily average the remainder of this year. Allowable days will be held down, and any increases in production and pipe line runs will arise from new fields and new wells in existing fields.

Southeast New Mexico. Lea County, New Mexico, currently heads the list of most active drilling counties. This work is distributed over numerous fields, many with multiple pays. It affords a healthy situation. The drilling is being done by many companies and operators. No single field has any great number of rigs at work. But many fields have some drilling.

West Texas. The same situation prevails in West Texas. The widespread drilling involves shallow, semi-shallow and deep operations.

It is noteworthy that Gulf Oil Corporation is conducting and has scheduled the greatest amount of field development among all operators. This ambitious program will be continued for an indefinite period of years on the O'Brien 22,400-acre leasehold in the Ward-Winkler County sector of the North Ward-Estes shallow field; the Hutchings Stock Association 30,450-acre leasehold in the Ward County portion of the same field; the Goldsmith 19,840-acre ranch in Ector County, centering upon the Goldsmith multi-pay field; and especially the Waddell Ranch in Crane County, where the company's leases extend into the majority of the fields of the county. The W. N. Waddell Ranch lease involves 31,146 acres. The W. N. Waddell et al ranch lease involves 45,771 acres.

Also due for steady development is the Keystone Ranch lease, consisting of 26,043 acres and embracing portions of a number of deep and shallow fields in Winkler County.

The ambitious development program of Gulf Oil Corporation is based in part on lease commitments. The lease obligations assumed by the company upon the purchase of the big ranch leaseholds prior to the introduction of proration restrictions in the Permian Basin require the projected development of established fields and the exploratory tests assigned to promising geophysical-geological prospects outlined on untested portions of the big leaseholds.

The scheduled operations by Gulf have a great impact on the over-all

picture in West Texas. The company's activities frequently stimulate competitive drilling as it approaches offset leases in Crane, Ector, Ward and Winkler counties.

Many Fields, Much Drilling. West Texas does not have a major development in any single area. But with so many fields, and those with multiple pays, offering proved undrilled locations, only a token volume of development in the majority of fields provides an aggregate volume that is unequalled in the nation.

Shallow Development. Shallow drilling has made a big comeback. This has been due to the effectiveness of fracture treatment of formations that did not respond to nitro shot and acid treatment. This is true in the Howard-Glasscock-Mitchell-Scurry area, and especially true of the Yates and Queen zones in Ward, Winkler and Andrews counties, as well as to the west in Lea and Eddy counties, New Mexico.

Delaware Basin. Successful fracturing has been the deciding factor in numerous commercial developments of the Delaware sand areas in the Delaware Basin of far West Texas and in southern Lea and Eddy counties, New Mexico.

A new oil strike centering upon the Loving-Ward County line is shaping up for a sizable producing area. The discovery was designated "Twofreds (Delaware) field," and the Ward County sector as the Hazida (Delaware) field. They are to be united, so will account for quite a bit of new drilling over the next 12-month period. The Delaware Basin has come through nicely with new fields in the past year or so, as discovery well cards will confirm.

The Delaware Basin has been forced to rely largely upon the Pasotex Pipe Line multiple line to El Paso for markets, and refinery capacity is or has been enlarged to keep pace with this isolated development. Product lines extending westward and northward from El Paso assure continued growth of market.

Deep Devonian Fields. Deep-seated Devonian producing structures in the upper portion of the Central Platform region, especially in Andrews, Gaines and Cochran counties, and across into Lea County, have accounted for considerable exploratory work and field development. They will continue to be prime targets for the wildcatter, because of their unusually high average crude recovery per acre performance record.

These Devonian producing areas are mostly comparatively small. But ultimate recovery of from 200,000 to 400,000 barrels per well is not uncommon. Some of the Devonian structures also account for shallower Pennsylvanian production.

Multiple Pays, Many Wells. The presence of multiple pays in deep fields quickly piles up a substantial backlog of proved locations to drill on a single unit. Right now the Bakke field in Andrews County is an example. There are also numerous other areas in the same county that will be moderately active for some years.

The same is true of the North Monahans and Halley multi-pay deep pay areas in Winkler County, and the big Goldsmith area, Ector County.

Considerable additional development is in store for the newly designated Running "W" (Waddell) field, Crane County, representing the consolidation of the Reed, North Reed, Block B-27 and Block B-21 fields, Crane County, extending in a general north-south trend for ten miles, with an average width of one plus miles. The "Waddell" part of the name is to designate that it produces from the Waddell sand zone of the Simpson series. Pay is within the 5900-6100 foot level.

Gas Wells to Gain Markets. Greater emphasis will be placed

TABLE 1
Capacity of Main Pipe Lines and Daily Average Oil Movement in March, 1957, from West Texas and Southeast New Mexico

Pipe Line Company	Main Line and Size in Inches	Capacity (Barrels Daily)	Oil Moved (Barrels Daily)
CRUDE OIL MAIN LINES			
Atlantic	10" to Atreco (Beaumont)	47,000	46,916[1]
Atlantic	10" to Refugio (Gulf Coast)	45,000	45,187[2]
Basin	22" to Wichita Falls	350,000	255,284
Humble	8" to Baytown (Houston)	44,000	14,941[3]
Humble	12" to Harbor Island (Corpus Christi)	58,000	57,718
Humble	18" to Satsuma (Houston)	132,000	135,200
Magnolia	Two 12" to Corsicana	165,000	137,331[4]
Pasotex	Two 8" to El Paso	55,000	58,281[5]
Phillips	12" to Borger (Panhandle)	73,000	48,002
Phillips	10" to Sweeny (Houston)	39,000	36,755[9]
Rancho	24" to Houston	257,000	255,675
Service	16" to Drumright, Oklahoma	166,400	139,888
Service	10" to Bowie, North Texas	33,000	31[6]
Shell	10" to Cushing, Oklahoma	41,000	17,696[7]
Texas-New Mexico	12" to Houston	68,000	69,814
West Texas Gulf	26" from Colorado City to Wortham and Longview	440,000	391,627[8]
	Total, Crude Oil Main Lines	2,013,400	1,710,346
PRODUCTS MAIN LINE			
Phillips Pet. Co.	8" from Odessa to Borger	38,000	36,830[10]

[1] Includes 5,112 barrels per day injected at Bronte.
[2] Includes 3,412 barrels per day injected at Big Lake.
[3] Represents oil moved out of West Central Texas to Kemper Station.
[4] Does not include injections at Merkel and Sweetwater.
[5] Pumpings through this carrier limited to capacity of El Paso Refineries.
[6] This figure represents oil injected in Kent County. 34,259 barrels per day of West Central Texas crude also moved through this carrier.
[7] 9,007 barrels per day injected into this line in North Texas.
[8] Includes 274,362 barrels per day delivered to Colorado City by Mesa Pipe Line.
[9] Line moves both crude oil and natural gasoline plant production.
[10] Line moves natural gasoline and other liquefied petroleum gas products.

henceforth on the development of numerous gas fields in the West Texas portion of the Permian Basin. For they are in line to receive their first natural gas trunk line outlets or to gain additional market by enlargement of existing lines.

Natural gas development in the extreme south and southwest portions of the Basin will take an upturn in anticipation of an adequate market outlet. New lines to be build by El Paso Natural Gas Company and the Permian Basin Pipe Line Company are awaiting approval of the Federal Power Commission. Enlarged drilling programs are due for Schleicher and Sutton counties, where both trunk line companies have contracted for supplies.

Permian Basin Pipe Line Company proposes to continue south and provide initial outlet for the Vinegarone field in the northeastern corner of Val Verde County. It is an expansive gas zone, with exceptionally high formation pressures.

The Permian Basin system is affiliated with Northern Natural Gas Company, which carries gas into Kansas, Nebraska, Iowa, South Dakota, and Minnesota.

El Paso Natural Gas Company seeks to build a 176 mile 20-inch carrier from the Sonora area, Sutton County, to Hobbs, N. M. El Paso has been drilling out its gas reserves in the Sonora area, and probably will build its own line. The Permian Basin line meanwhile has contracted for more than adequate gas supply for its longer unit.

Biggest Gas Reserve. The Puckett multi-pay field, Pecos County, where high pressure sweet gas is obtainable from thick pay zones of Pennsylvanian, Devonian, and Ellenburger, is experiencing a stepped up drilling program. It is based on the fact that additional plant facilities have been provided for elimination of the carbon dioxide content of the gas. This field in the 10,000 foot Pennsylvanian is the largest and deepest gas reserve in the basin.

A gas reserve of considerable magnitude from the Delaware zone was uncovered early this year in the Worsham area, southeastern Reeves County. Development is being accelerated by short term leases and the favorable prospects for an early pipe line outlet. Gulf Oil Corporation opened the Worsham gas area. Holding short term leases, it had to jump out with follow-up drilling that has since proved a big area for the 5000 foot Delaware gas. The field is not very far from El Paso Natural Gas Company's trunk line into the Santa Rosa gas area, Pecos County.

Development of the Emperor multi-deep pay gas area in Winkler County is being expanded to supply a major pipe line outlet that has been assured for the area. **—The End**

Current Activity in the Basin

1.7 million-bpd average accounts for more than 1/5 of U. S. production, 1/10 of world output

By CECIL W. SMITH
WORLD OIL Staff

THE PERMIAN BASIN has long been one of the most important oil regions of the world and today it appears to be far from reaching its peak. This basin underlies about 75,000 square miles of West Texas and southeastern New Mexico and is now producing more than one-fifth of all U. S. oil and one-tenth of all produced in the world.

Few countries are even in the same league with the Permian Basin when oil production volumes are compared. Venezuela, and of course the U. S., are the only ones to top this great province. No single nation in the oil-prolific Middle East has matched its oil flow.

Despite its high position in world rank, the Permian Basin still must be content with third place among the great oil regions of the U. S. The much larger Mid-Continent maintains firm hold on the lead among domestic producers, and the smaller, but older, Gulf Coast manages to nose out the Basin for second place. Many believe that it will only be a matter of time before the reverse of this will be true.

Currently, flow of oil from Permian Basin is averaging almost 1,700,000 barrels a day. That accounts for almost 22 percent of the nation's output, while the Mid-Continent's 2,214,000 barrels daily is more than 28 per-

Wells And Footage Drilled In Permian Basin Have Greatly Increased Since 1946

	WELLS				FOOTAGE			
YEAR	West Texas	New Mexico	Total	% of U.S.	West Texas	New Mexico	Total	% of U.S.
1946	2,472	415	2,887	9.6	10,771,512	1,649,516	12,421,028	12.3
1947	2,227	538	2,765	8.3	10,619,179	2,351,290	12,970,469	11.5
1948	3,317	542	3,859	9.8	15,764,298	3,206,171	18,970,469	13.2
1949	3,284	484	3,768	9.6	16,417,982	2,196,522	18,614,504	13.4
1950	5,054	542	5,596	12.9	26,894,552	2,474,639	29,369,191	18.4
1951	5,383	540	5,923	13.2	29,293,100	2,985,174	32,278,274	18.5
1952	5,125	713	5,838	12.7	30,046,661	4,648,533	34,695,194	18.6
1953	3,691	784	4,475	9.0	20,150,787	5,445,959	25,596,746	12.9
1954	4,177	785	4,962	9.6	23,671,570	4,540,296	28,211,866	13.5
1955	5,340	1,114	6,454	11.5	28,388,967	4,965,102	33,354,069	14.6
1956	5,592	1,103	6,695	11.5	28,071,073	5,292,671	33,363,744	14.2
1957: 3 Months	1,643	397	2,040	15.1	7,901,778	1,891,918	9,793,696	17.5

cent, and Gulf Coast's 1,925,000 bpd rate amounts to almost 25 percent.

The major portion of this vast geologic basin lies within the Texas borders, and closely approximates geographical divisions designated by the Texas Railroad Commission as Districts 7-C and 8. It is the Texas part of the area that accounts for the major part of its oil production. Latest gage showed that 84 percent of total oil take from the Basin came from the Texas side. The other 16 percent was New Mexico's share.

While this year's U. S. drilling program is presently trailing last year's record activity by 7 percent, work in the Permian Basin is being carried on at a greater clip. There are slightly fewer rigs at work at present than were being used a year ago, but so far this year the number of wells drilled has exceeded the year-ago record by almost 20 percent.

About 15 percent of the wells drilled in the nation each year are located in the Permian Basin, and these account for almost 17 percent of the total footage drilled annually.

Some of the world's finest drilling tools, techniques, and methods are employed in this vast development of the Permian Basin. Here, about 12 percent of the nation's active rigs are drilling 17 percent of the over-all footage. At the end of April there were 594 rigs at work in the area, with 487 of these on the Texas side, and 107 in New Mexico. That was a gain from the 579 at end of March.

Of the 594 active drilling rigs 70 (about 12 percent) were cable tool rigs, with the remaining 88 percent being rotary tools.

Permian Basin Accounts For Large Part Of Current U. S. Drilling And Crude Production

(Data for March, 1957)

REGION	Daily Crude Production		Monthly Well Completions				Rigs Operating	
	Barrels Daily	% of U.S.	Wells	% of U.S.	Footage	% of U.S.	Number	% of U.S.
Permian Basin (Tex. Dists. 7-C, 8; S.E. New Mexico)	1,696,100	21.8	622	14.2	2,923,293	16.1	579	12.5
Mid-Continent (Tex. Dists. 1, 5, 6, 7-B, 9, 10; Ark., Kans., N. La., Mo., Okla.)	2,213,700	28.4	2,085	47.6	7,032,574	38.7	1,813	39.2
Gulf Coast (Tex. Dists. 2, 3, 4; Ala., Fla., Ga., S. La., Miss.)	1,924,700	24.7	567	12.9	4,417,744	24.3	669	14.5
West Coast (Calif., Ore., Wash)	936,800	12.0	182	4.2	816,973	4.5	176	3.8
Rky. Mts. (Ariz., Colo., Neb., N.W. New Mex., Nev., N. Dak., Mont., S. Dak., Utah, Wyo.)	624,100	8.0	291	6.6	1,538,150	8.5	296	6.4
Middle West (Ill., Ind., Ky., Mich., Ohio, Tenn.)	352,200	4.5	461	10.5	982,255	5.4	691	15.0
Appalachian (N.Y., Pa., Va., W. Va.)	36,800	0.5	174	4.0	442,799	2.4	397	8.6
Total United States	7,784,400	....	4,382	....	18,153,788	....	4,621	....

Crude Oil Production in Permian Basin Has Doubled in Past 10 Years

Sources: Texas, 1921-1938, private sources; 1939-1956, Texas Railroad Commission; January-March, 1957, A.P.I. . . . New Mexico, 1924-1946, private sources; 1947-1948, New Mexico Oil Conservation Commission; 1949-January, 1957, U. S. Bureau of Mines; February-March, 1957, A.P.I.

(Data in Barrels)

YEAR	TEXAS DISTRICT 7C		TEXAS DISTRICT 8		TOTAL WEST TEXAS		S. E. NEW MEXICO		TOTAL PERMIAN BASIN	
	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily
1922-1945	192,893,667	22,000	1,520,374,500	173,450	1,713,268,167	195,450	451,490,343	51,500	2,164,758,510	246,950
1946	10,075,235	27,600	180,813,239	495,400	190,888,474	523,000	35,282,263	96,650	226,170,737	619,650
1947	13,906,004	38,100	206,514,967	565,800	220,420,971	603,900	40,521,243	111,000	260,942,214	714,900
1948	16,668,257	45,550	259,453,586	708,900	276,121,843	754,450	47,235,804	129,050	323,357,647	883,500
1949	16,807,896	46,050	210,767,351	577,450	227,575,247	623,500	47,310,000	129,600	274,885,247	753,100
1950	20,917,096	57,300	262,985,846	720,500	283,902,942	777,800	47,036,000	128,850	330,938,942	906,650
1951	35,988,102	98,600	341,617,737	935,900	377,605,839	1,034,500	52,392,000	143,550	429,997,839	1,178,050
1952	54,182,303	148,050	341,853,271	934,000	396,035,574	1,082,050	58,778,000	160,600	454,813,574	1,242,650
1953	59,501,130	163,000	327,499,912	897,250	387,001,042	1,060,250	69,639,000	190,800	456,640,042	1,251,050
1954	63,713,643	174,550	307,924,373	843,650	371,638,016	1,018,200	74,408,000	203,850	446,046,016	1,222,050
1955	64,103,199	175,600	344,604,652	944,100	408,707,851	1,119,750	81,381,000	222,950	490,088,851	1,342,700
1956	63,894,745	174,550	385,430,447	1,053,100	449,325,192	1,227,650	86,479,000	236,300	535,804,192	1,463,950
1957: First 3 Months	15,771,500	175,250	106,653,200	1,185,050	122,424,700	1,360,300	23,288,000	258,750	145,712,700	1,619,050
Total	628,422,777	48,800	4,796,493,081	372,500	5,424,915,858	421,300	1,115,240,653	86,600	6,540,156,511	508,350

New Drilling Fluids in the Permian Basin

In most cases, low solids muds show increased penetration rates over conventional fluids

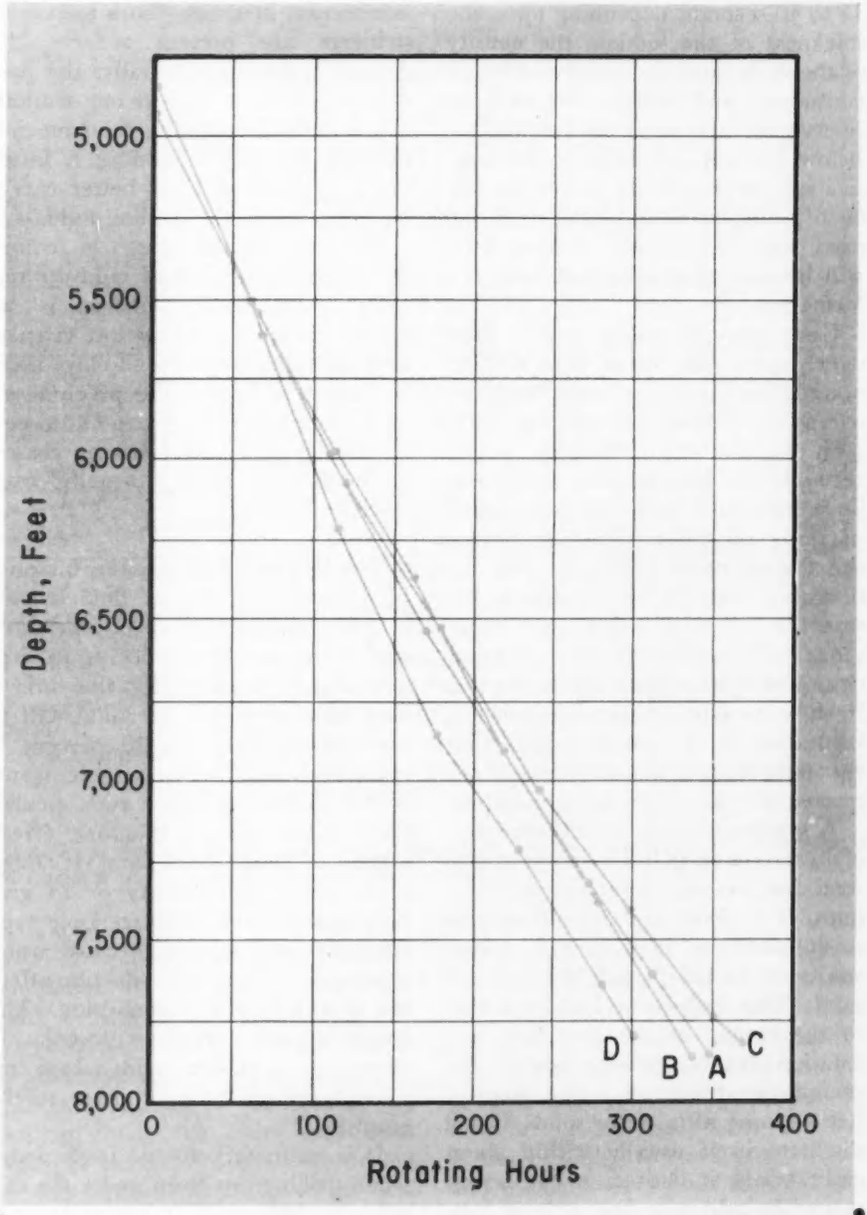
By HARRIS A. OEHLER
Permian Mud Service, Incorporated
Odessa, Texas

SOLIDS CONTENT of drilling fluids has prompted much discussion and study as to the manner in which they affect the penetration rate. In a recent research project conducted by the Battelle Institute for the AAODC in determining the effect on penetration rate by solids content, it was pointed out that both the amount of solids and type of solids influenced the penetration rate. Other recent articles delve more fully into the reasons for this retardation.

The purpose of this article is to show how these findings have been incorporated into many current drilling fluid programs that as a result have brought about recent changes and improvements. Since solids have been shown to have an adverse effect on the penetration rate, much of the recent drilling fluid development has been directed toward solids reduction (low solids CMC or Driscose muds and muds using desanders) or solids elimination (flocculants and oil-in-water emulsion fluids).

Other recent types of drilling fluids are inhibitive in nature. Often their solids content are treated to create within the system "controlled flocculation" or "controlled dispersion" (low lime-low alkalinity-controlled solids surfactant muds, calcium sulfate surfactant muds, and surfactant muds). Invert (water-in-oil) emulsion muds have been used for maximum pay-zone protection.

Flocculants. Organic flocculants are being used frequently in the Permian



	Gel Chemical		Oil Mud	Driscose Mud
	Well A	Well B	Well C	Well D
Footage Drilled	2930	2935	2850	2980
Number of Bits	34	31	33	27
Rotating Hours	342	333	367	297
Avg. Feet per Bit	86	94	86	110
Avg. Feet per Hour	8.5	8.8	7.7	10.0
Avg. % Inc. in Feet per Rate	—	—	—	20%
Avg. % Inc. in Feet per Bit	—	—	—	24%
Total Mud Cost	$4,000	$4,200	$4,800	$3,800

* Bentonite to high viscosity Driscose ratio 7-to-1 sack basis (14-to-1 pound basis).

FIGURE 1—Comparative penetration rates. Driscose oil emulsion mud (wells drilled in same area by same rig in Winkler County).

Basin to precipitate all solids from the drilling fluid when drilling through the red bed shales. In areas where these flocculants are being used, the red bed shales are encountered somewhat above the salt section. In ordinary drilling, the red bed shales become dispersed into the mud until the viscosity ranges from about 31 to 40 seconds, depending upon the thickness of the section, the density of the shale, and the amount of water consumed, and whether or not the reserve pit was used for circulation. Below the red bed shales is the massive salt section. If the water has not been presaturated with salt, or brine used initially then the drilling fluid will become near saturated from the formation.

Guar gum has been used a little over two years. From 200 to 700 pounds per well are used, with an average of 400 to 500 pounds. Guar gum is almost universally added through the hopper. The water can be presaturated with salt, brine used, partially saturated with salt before the flocculant is added, or else the flocculant can be added shortly before the salt section is topped. Guar gum is far more effective, concentrationwise, in a salt solution than in fresh water where it is subject to fermentation. It is recommended that the fluid be circulated through the reserve pit to obtain better settling.

A synthetic water soluble commercially prepared polyelectrolyte can be used for the same purpose as Guar gum. It is about equally effective in fresh water as it is in salt water. About 50 to 125 pounds per well are used. This polyelectrolyte is added to the system at the flow line in a solution made up with about 2½ pounds per barrel of water. Since it has a strong affinity for solids, it will dissipate itself /usually within about eight hours, if desired, it can be removed by adding a few sacks of bentonite to the system.

The main advantages of the above flocculants are that; greater penetration rates and nearer gage hole can be obtained. Less water is used in drilling, and that can become a factor where water is scarce. When the drilling fluid is saturated with salt from the formation, less formation salt is dissolved because of salvaging more of the salt water. A savings in cement can be realized. The decreased washing and dissolving of the salt section in areas where anhydrite stringers are present reduces the danger of keyseats. Finally, the prevention of large washed out sections would keep the drilling fluid moving through the salt section at a faster linear velocity assuring better carrying capacity of the drilling fluid.

The main disadvantages of removing all solids are cost of mud-up and some fill-up. When mud-up is required, usually to carry lost circulation material, commercial clays must be added in lieu of the precipitated native red bed clay. Some fill-up can be encountered when drilling ceases, although drillers are usually cautioned.

Oil-in-Water Drilling Emulsions. In general, this type of fluid is used in the upper section of the hole where the usual practice is to drill with water. Occasionally, this fluid is used as a substitute for mud. Oil in the amount of 3 to 10 percent is emulsified into fresh or salt water with a special nonionic type emulsifier. Often some Driscose (fresh water) or starch (salt water) is added to improve the stability or to give fluid loss control. This nonionic type emulsifier was selected because usual dissolved contaminates do not affect the stability of the emulsion. The emulsifier also exhibits a flocculating effect on the drilled soiids which imparts a self-cleaning property to the emulsion.

It is customary to use fresh water when drilling out from under the salt string to 6000 to 10,000 feet, depending upon the locale, at which depth the system is mudded up. In areas where the teeth of the bit outlast the bearings, bit life can be increased due to the better lubricity. At the same time, the drilling rate remains about equal to that of water. For wells that are drilled to the Clearfork with the salt section open, a salt water oil emulsion fluid can be used from approximately 3900 to 5500 feet.

This emulsion fluid has been used in certain places for sample mud since it brings up good samples for the geologist and keeps a cleaner hole for testing. The oil content should be at least 4 to 5 percent. In Table 1 a comparison is given between two adjacent wells in the Joe Mills field where this oil emulsion fluid was used as a partial substitute for the usual mud. Both wells were drilled by the same rig for the same producer. In the case cited total depth was reached with fewer bits, fewer rotating hours and with a reduction in the over-all mud cost.

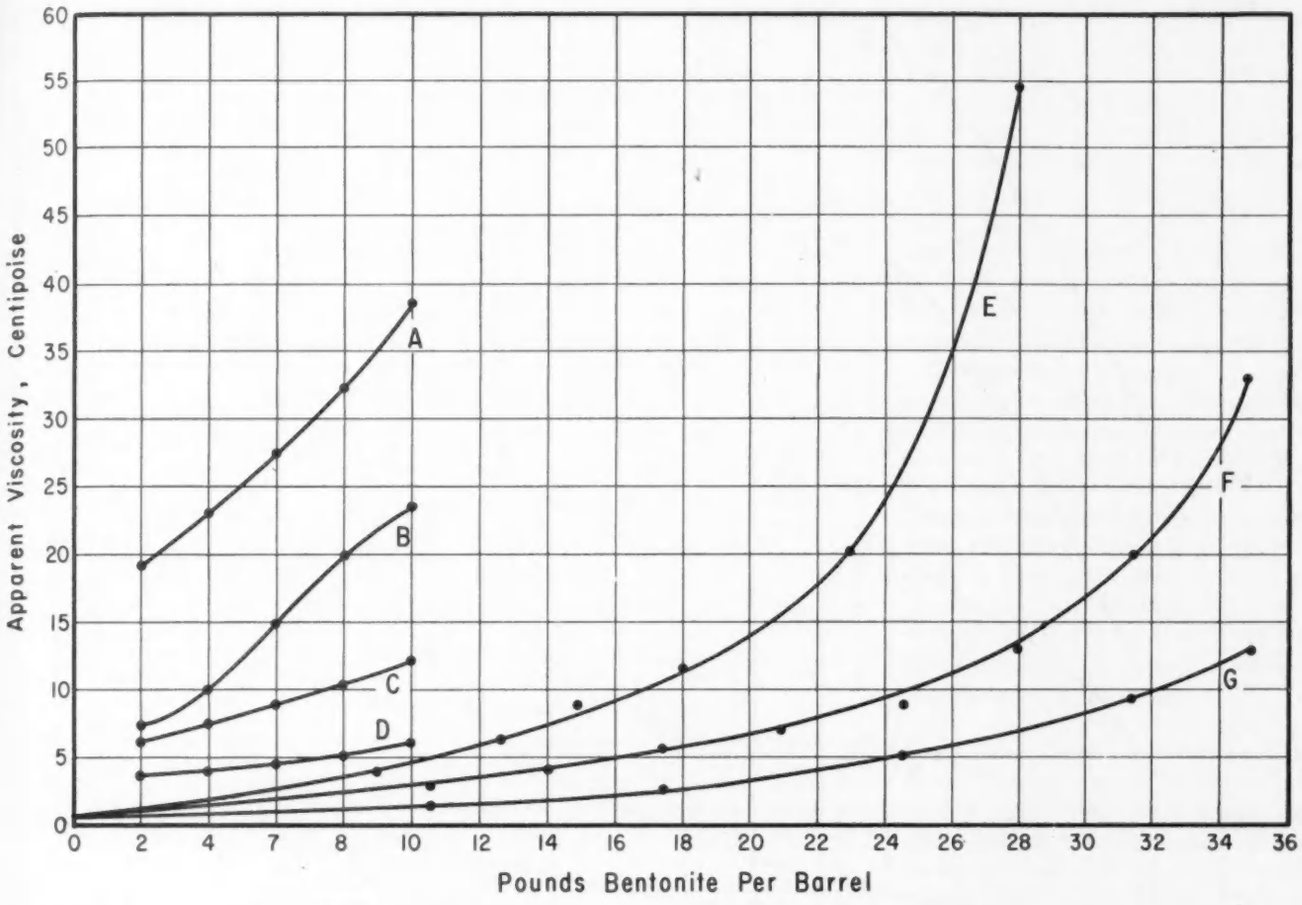
The advantages are savings in bits and trip time and occasionally in mud. The main disadvantage is the cost of the fluid when the emulsion is competing with water.

Low Solids Type Muds. The term "low solids mud" is used to describe a type of drilling fluid where high viscosity and/or medium grades Driscose have partially, and in a few instances wholly, substituted for bentonite. In almost all cases bentonite and Driscose are used to compliment each other. These muds when compared to the conventional bentonite-chemical type muds will show a reduction in volume per percent solids content for comparable viscosity muds, whether weighted with barite or not. This reduction will vary from a small to a substantial decrease in solids. As with conventional muds, the low solids muds are run with and without all standard chemicals and with and without oil additions, all additions being made for similar reasons. Low solids muds inherently possess low to moderate fluid losses. However, it has been proven and repeatedly pointed out that lower fluid losses without increase in solids content is independent of the penetration rate.

The low solids mud, a few years ago, was compounded so that the ratio of bentonite to Driscose was 10 to 1, sack basis (20 to 1 pound basis). At the time medium grade Driscose accounted for about 100 percent of all Driscose used. With the reintro-

TABLE 1—Comparison of Wells Using Oil Emulsion and Conventional Muds in Joe Mills Field.

	Well 1	Well 2
Interval Compared, 7⅞ in hole	3200–7880 ft.	3200–7920 ft.
Bits	28	25
Rotating Hours	325½	299
Drilling Fluid Program:		
Water	3200–5800 ft.	3200–5800 ft.
Oil Emulsion		5800–7450 ft.
Low pH Bentonite Chemical Mud	5800–7880 ft.	7450–7920 ft.
Total Mud Cost	$5500	$4720



Curve A: HV Driscose and bentonite in distilled water.

Curve B: HV Driscose and bentonite in water containing 350 ppm $CaCO_3$ total hardness. (CaH 160 ppm; MgH 190 ppm), Chloride 175 ppm (salt 290 ppm).

Curve C: HV Driscose and bentonite in water containing 490 ppm $CaCO_3$ total hardness (CaH 300 ppm; MgH 190 ppm), Chloride 3,750 ppm (salt 6,200 ppm).

Curve D: HV Driscose and bentonite in same water as Curve C plus ¼ lb/bbl caustic and ¼ lb/bbl quebracho.

Curve E: Bentonite only, aged in distilled water.

Curve F: Bentonite only, in same water as Curve B.

Curve G: Bentonite only, in same water and chemical treatment as Curve D.

FIGURE 2—The effect of ½ lb/bbl high viscosity Driscose on apparent viscosity with varying amounts of bentonite in distilled and contaminated waters as compared to bentonite only, under the same conditions.

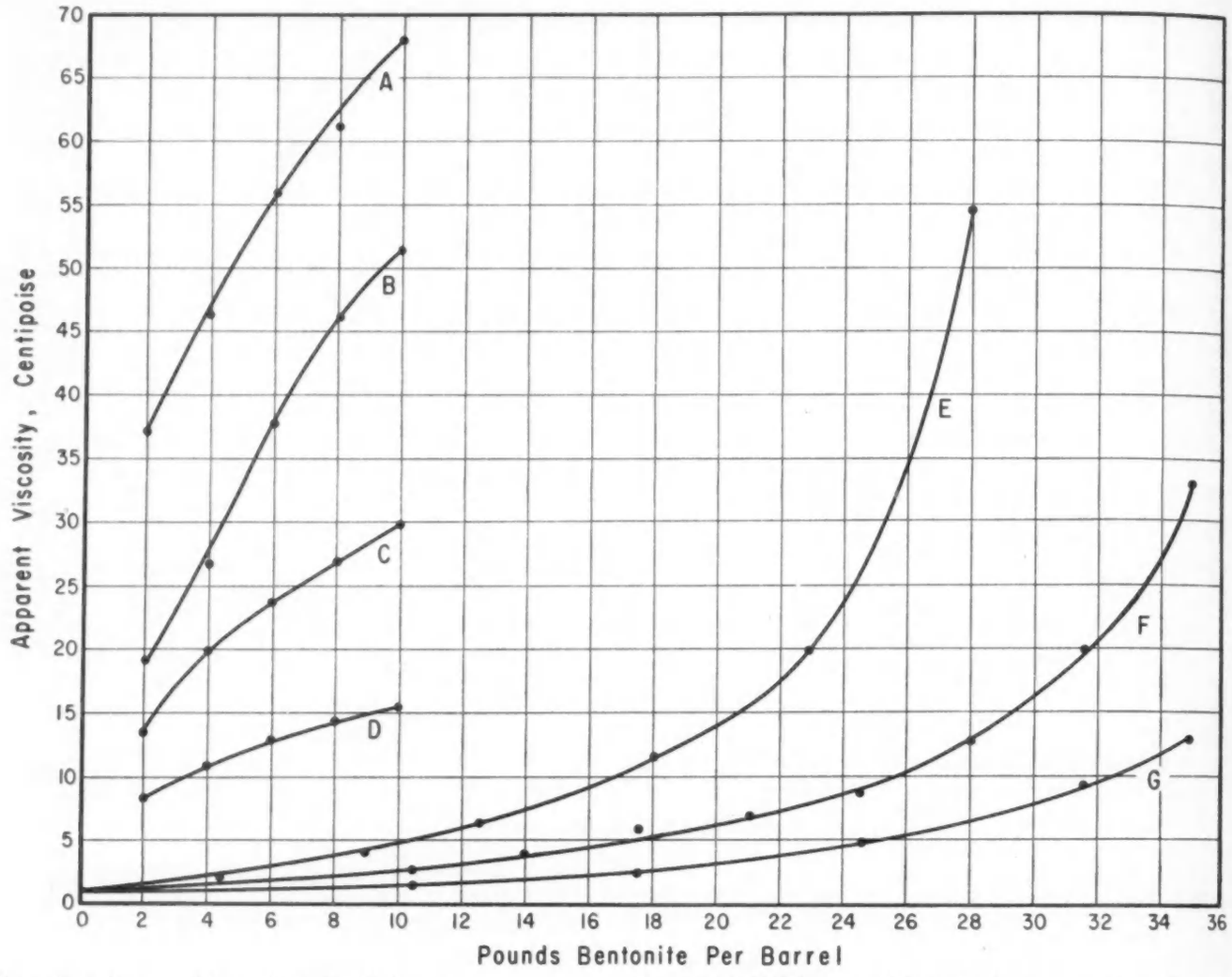
duction of the high viscosity grade Driscose, along with considerable field experience, the ratio of bentonite to Driscose varies from 4 to 1, through 10 to 1, sack basis. The ratio is flexible so as to obtain optimum results. High viscosity grade Driscose at present accounts for approximately 85 percent of the Driscose used in the Permian Basin.

Low solids muds are applicable to most areas in the Permian Basin. Usually low solids muds have shown an increase in penetration rate when compared to wells using conventional type muds. The cost may be the same, or in some cases, a little higher than a conventional mud; but there will be an over-all reduction in the cost of completing a well.

A comparison between low solids muds and conventional muds for four wells drilled in the Keystone field is given in Figure 1. For the interval compared, Well D using a low solids mud with a bentonite to high viscosity Driscose ratio of 7 to 1 shows an increase in the penetration rate with a reduction in the cost of the drilling fluid. All four wells used high pH muds. All wells were drilled by the same contractor, crews, and rig for the same producer.

A typical drilling fluid program in the Brownfield area and surrounding counties is as follows. The main contamination problem occurs between approximately 5500 to 9000 feet in the form of soft calcium and gyp. In this section it is difficult to run conventional muds without sticking the drill pipe. Somewhat below this depth, shale is the major source of contamination. At mud up, bentonite and high viscosity Driscose are added in a ratio of 8 to 1 sack basis until the desired viscosity is reached. One thousand pounds caustic soda and 100 pounds quebracho are added along with 5 percent oil if allowed by the operator. Water in the amount of a ½-inch stream is added at the flow line at all times while drilling. If the pits fill, they are jetted down and the bottoms cleaned as necessary, but the water is not stopped.

This type of mud at make-up has a pH of 12 to 12.5 and a P and M alkalinity near 3.0 with the OH ions ranging from 850 to 1000 ppm. To a depth of 8000 to 9000 feet, the tourly treatment consists of about 300 pounds caustic soda with little or no quebracho. At 9000 feet, the caustic soda treatment is reduced so that by 10,000 feet the system requires only 100 to 200 pounds daily. Before reaching the shale section, the bentonite to high viscosity Driscose ratio



Curve A: Driscose and bentonite in distilled water.

Curve B: HV Driscose and bentonite in water containing 350 ppm $CaCO_3$ total hardness (CaH 160 ppm; MgH 190 ppm) Chloride 175 ppm. (salt 290 ppm).

Curve C: HV Driscose and bentonite in water containing 490 ppm $CaCO_3$ total hardness (CaH 300 ppm; MgH 190 ppm), Chloride 3,750 (salt 6,200 ppm).

Curve D: HV Driscose and bentonite in same water as Curve C plus ¼ lb/bbl caustic and ¼ lb/bbl quebracho.

Curve E: Bentonite only, aged in distilled water.

Curve F: Bentonite only, in same water as Curve B.

Curve G: Bentonite only, in same water and chemical treatment as Curve D.

FIGURE 3—The effect of 1 lb/bbl high viscosity Driscose on apparent viscosity with varying amounts of bentonite in distilled and contaminated waters as compared to bentonite only, under same conditions.

is reduced to about 4 to 1 sack basis and maintained to total depth. This is because of partial incorporation of the shale into the mud.

This type of low solids mud has been found to provide safety, economy and better penetration where proper maintenance is given. It is much easier to engineer, since dependence upon the contractor for jetting, cleaning and proper water additions are not so critical. In Table 2, a comparison is given of six mud bills of wells drilled by various contractors for five different producers. These wells are located in the tri-county border area of Terry, Yoakum, and Gaines counties. All wells were wildcats.

The manner in operating low solids muds varies from area to area. In certain areas where some lost circulation is encountered, the ratio is held constant at 8 to 1 with oil added as required or permitted but with no chemical additions. At present, the ratio of bentonite to high viscosity Driscose varies from as low as 4 to 1 to as high as 10 to 1 sack basis. The ratio has generally been held constant in the past, but this is changing. The pH control depends upon the amount and type of contamination. In the southern half of the Permian

TABLE 2

Drilling Fluid Costs of Six Wildcat Wells in the Tri-County Border Area of Terry, Yoakum and Gaines Counties Drilled by Various Contractors for Five Different Producers

	High pH Conventional Mud Program			Low Solids Mud Program		
				Low pH Constant Ratio 8 to 1	High pH Variable Ratio	
					No Oil	With Oil†
	Well I	Well II	Well III	Well IV	Well V	Well VI
Depth of Intermediate Casing, ft.	5,035	5,150	5,000	5,060	4,448	5,284
Total Depth, ft.	13,360	13,050	12,818	13,465	11,760	12,700
Total Mud Cost	$22,834	$14,863	$13,472	$12,844	$9,621	$8,876†

*Oil consisted of 9,450 gal. No. 2 diesel oil and 295 gal. No. 5 fuel oil.
†This included $1,323 for the diesel oil and $135 for the fuel oil.

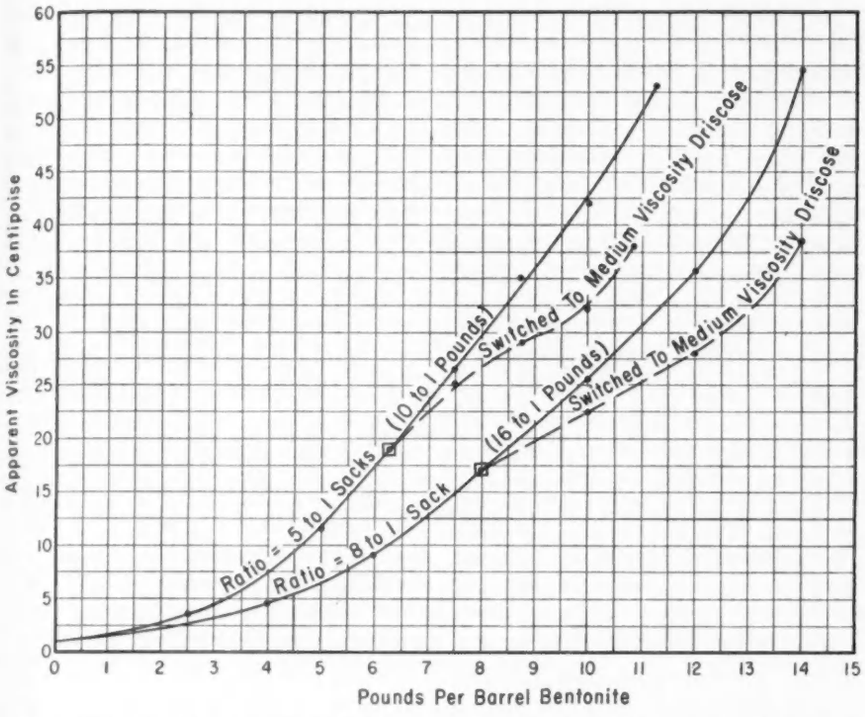

Apparent Viscosity In Centipoise
Pounds Per Barrel Bentonite
Ratio = 5 to 1 Sacks (10 to 1 Pounds)
Switched To Medium Viscosity Driscose
Ratio = 8 to 1 Sack (16 to 1 Pounds)
Switched To Medium Viscosity Driscose

FIGURE 4—The effect on apparent viscosity of varying amounts of high viscosity Driscose and bentonite at constant ratio of 5-to-1 and 8-to-1 sacks (10-to-1 and 16-to-1 pounds); also showing the effect on apparent viscosity of constant ratio when switching to regular grade Driscose at a selected point. Plot conditions: High viscosity Driscose (and regular grade Driscose) and bentonite in water containing 380 ppm $CaCO_3$ total hardness (CaH 195 ppm and MgH 185 ppm) chloride 180 ppm (salt 297 ppm).

Basin, there is a greater preference for a low pH mud. It is not infrequent with low solids muds to have 0-0 to 0-3 gel strengths. In the Tatum area in New Mexico, high pH low solids muds are being used in place of salt water type muds where the salt content varies from 2 to 8 percent. Finally, low solids muds have been employed in certain wells for sample muds. Thus, it can be seen that low solids muds have a wide application and that there is a great degree of flexibility for each application.

Data are presented in Figures 2, 3 and 4 for blends of bentonite and high viscosity Driscose under several different conditions. These curves can aid in selecting the optimum ratio as required by the types and amounts of contaminants in a given system. In Figures 2 and 3, the amount of high viscosity Driscose is held constant at ½ and 1 pound, respectively, for curves A, B, C and D. The waters for these curves contained the following contamination before hydration: none for Curve A; 350 ppm $CaCO_3$ total hardness and 290 ppm salt for Curve B; 490 ppm $CaCO_3$ total hardness and 6200 ppm salt for Curve C; identical water as Curve C plus ¼ lb/bbl. each caustic and quebracho for Curve D. With the exception of Curve E, all samples were stirred and aged for about 20 minutes. Curves E, F and G are pure bentonite solids in waters containing the same type of contamination respectively as Curves A, B and D. The bentonite-high viscosity Driscose curves when contrasted with corresponding pure bentonite curves illustrate the gain in viscosity of the bentonite-Driscose curves for equivalent amounts of total suspended solids.

When the ratio of bentonite to high viscosity Driscose is kept constant, curves of the type shown in Figure 4 illustrate the effect on apparent viscosity with increasing total solids. Parameters of 5 to 1 and 8 to 1 ratios are presented. If at any preselected point along these constant ratio curves medium grade Driscose would account for all further additions of Driscose, a "branch" curve results. This switch in viscosity grades reflects a decrease in the apparent viscosity for the same amount of total solids. The branch points in Figure 4 are only for the purpose of illustration and represent no criterion. Switching then from high viscosity to regular grade Driscose would be undesirable and is quite seldom done except for the following reasons: if a lower fluid loss is required with minimum increase in viscosity; and since the regular viscosity grade has a higher solids tolerance than the high viscosity grade, a lower 10 minute gel is possible if a switch is made near the upper limit of the practical viscosity range, this point being a function of the ratio and amount and type of contaminants.

Therefore, in summing up, inasmuch as the degree of dispersability of the drilled shales vary from area to area and formation to formation, it is necessary to alter the bentonite to Driscose ratio from time to time. This ratio will vary from 10 to 1 to, in some cases, zero bentonite. This change in ratio is dependent upon in addition to the type and yield of the drilled solids, jetting practices and amount of water added.

Surfactant and Inhibited Type Muds. A low lime-low alkalinity-controlled solids surfactant muds, calcium sulfate surfactant muds and surfactant muds are still largely in the development stage in the Permian Basin. The low lime-low alkalinity-controlled solids surfactant muds are the only one of these three that have been given area-wide application. These muds are similar to conventional low lime-low alkalinity muds except that pure and/or technical grades CMC as well as starch are used as viscosity agents in addition to fluid loss control. Also, a nonionic surfactant is added to muds without oil, but a nonionic emulsifier is added when oil is used. A threefold objective is intended, especially for drilling in the pay zone, with muds costing near conventional muds: 1) the actual fluid loss to the formation will be low, 2) the fluid that is lost will be inhibited, and 3) with the reduced surface tension the tendency for emulsion blockage in the pay zone is reduced. These muds have demonstrated their effectiveness in inhibiting shale sloughing. In the Virey field, a funnel viscosity of 90 to 150 seconds is required for drilling the Pennsylvania shale when using a conventional mud; however, drilling with this type of mud required only a 40 to 45 second viscosity. Development of various inhibited type muds currently is attracting increased interest in the Permian Basin. —**The End**

Air Drilling in Val Verde Basin

Controlled tests show tremendous savings in rig time, trips and bits used

By R. W. HORTON
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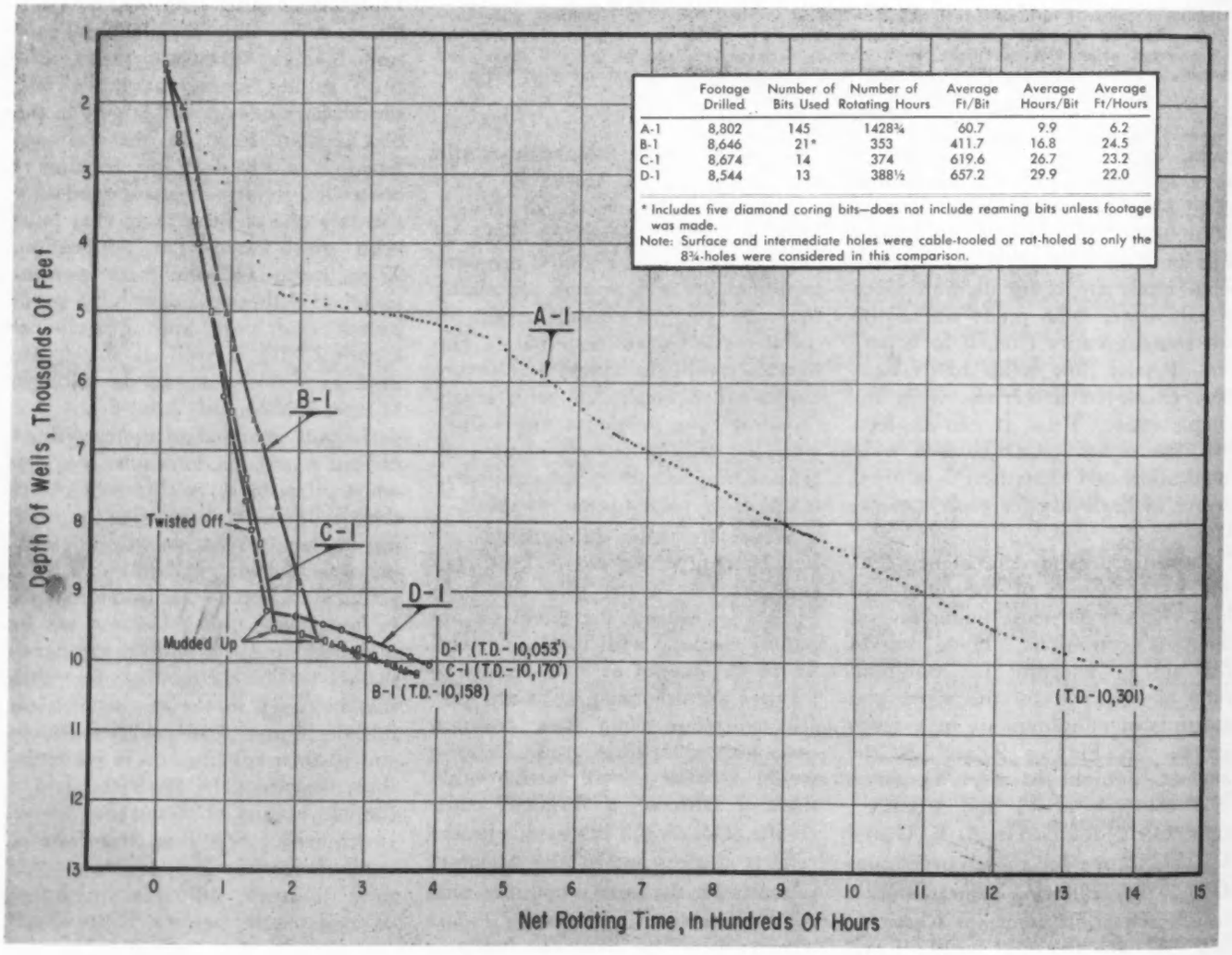
Phillips Petroleum Company
Odessa, Texas

IN THE NORTHEASTERN corner of Val Verde County and the southwestern part of Sutton County at the southern part of the Central Plains platform, major developments have been shaping up; not only from a gas production standpoint but also from experimental work in air and gas drilling. Phillips Petroleum Company opened a Strawn-Pennsylvanian gas distillate reservoir in early 1955 with their discovery well, Phillips Cauthorn A-1. It flowed 42 million feet of gas and 42 barrels of distillate per day from Strawn perforations at 9982 to 10,052 feet, and from 10,174 to 10,262 feet. Phillip's strike was some five miles southwest of the Vinegarrone field which was opened by R. J. Caraway in 1951 with a gasser from the Strawn.

The drilling progress of the Cauthorn A-1 is shown on Figure 1. This well was spudded in November, 1954. Drilling with mud it took 145 bits in the small, or production, hole.

In subsequent development work, Phillips has drilled their Cauthorn B-1, C-1 and D-1 (Figure 2). From bottom of the intermediate casing to approximately 9500 feet, these three wells were drilled with air or gas with various compressor and well head hook-ups. The C-1 encountered a stray gas sand at 9550 feet and blew out. It was necessary to mud up and the D-1 was arbitrarily mudded up at 9300 feet to prevent similar trouble. A number of interesting innovations were devised in this air drilling program that show considerable promise.

Carbide Bits: Carbide insert type bits, especially designed for jet bit drilling became standard below 3800 feet on the C-1 and D-1. These bits



	Footage Drilled	Number of Bits Used	Number of Rotating Hours	Average Ft/Bit	Average Hours/Bit	Average Ft/Hours
A-1	8,802	145	1428¾	60.7	9.9	6.2
B-1	8,646	21*	353	411.7	16.8	24.5
C-1	8,674	14	374	619.6	26.7	23.2
D-1	8,544	13	388½	657.2	29.9	22.0

* Includes five diamond coring bits—does not include reaming bits unless footage was made.
Note: Surface and intermediate holes were cable-tooled or rat-holed so only the 8¾-holes were considered in this comparison.

FIGURE 1—Penetration rate graph of net drilling time graph of the Cauthorn A-1 (drilled with mud), B-1, C-1 and D-1 all drilled with air and/or gas. Air or gas drilling resulted in a savings of over 1000 rotating hours and 120 bits and trips. Carbide insert bits were used on the B-1, C-1 and D-1.

have an air course in the leg of each bit that intersects the flattened ball plug so that the air can cool the bearing. From a study of the penetration rates and geologic data from the Cauthorn A-1, it was decided that these insert type bits would give the best service from approximately 3800 feet to 9700 feet. This was further indicated by comparison with successful uses of insert bits and mud drilling in the Pennsylvanian. Subsequently, the successful use of this type of bit on the Cauthorn B-1, C-1 and D-1 supported that decision.

A conventional hard formation bit was run in at 6551 feet on the B-1 and made only 265 feet in 9¼ hours before being pulled. This bit was run between two carbide insert type bits and proved Phillips contention that the insert type bits would perform much better through this section.

The insert type bits did not require the use of bottom hole reamers in the drill string. Phillips considers this a very important point as they believe that the gage wear is an important factor in the control of hole deviation. Therefore, the use of these insert type bits not only gave longer hours on bottom, but also provided a considerable savings in reamer costs.

Wellhead Connections. The wellhead connections varied from well to well. On the B-1, one 10-inch ram type blow-out preventer, one 12-inch full closing bag type preventer and one 10-inch rotating head were used. This well was drilled with air and gas.

On the C-1, which was drilled with air only, a double 10-inch 900 series hydraulic ram type and one 10-inch 900 series rotating head were used.

On the B-1, a one-inch, gas pilot, line was fastened along the top of the 250 foot long 10-inch blowdown line, or gas discharge line, so that it was possible to ignite the well returns and thus decrease the danger of a gas build-up in the area. This 1-inch line was tied-in to the 3-inch, 500 psig, line from a gas well in the immediate vicinity. This 3-inch line was a standby gas supply if the air compressors failed.

Figure 3 is a schematic of the wellhead connections used on the C-1 and D-1. Here Phillips used a common cotton gin blower in the exhaust line to keep a slight vacuum on the well annulus and also to thoroughly purge the exhaust line.

Compressors: Figure 4 shows the hook-up that was used on the B-1 where three standard construc-

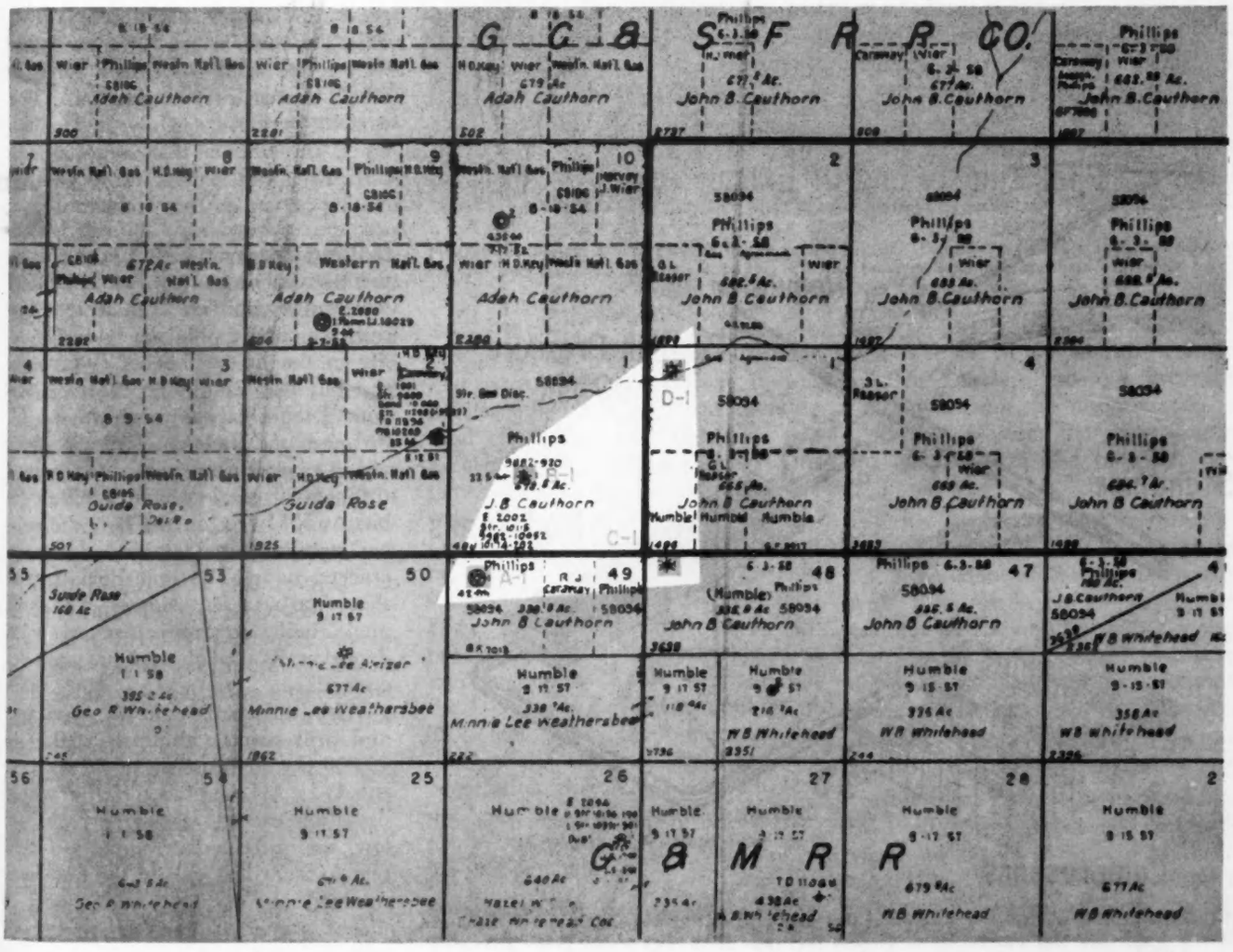


FIGURE 2—Plat of northeastern part of Val Verde County and southwestern part of Sutton County showing proximity of the four wells drilled by Phillips that are compared in this article. The initial well, Cauthorn A-1 was drilled with mud and the B-1, C-1 and D-1 were drilled with air and/or gas.

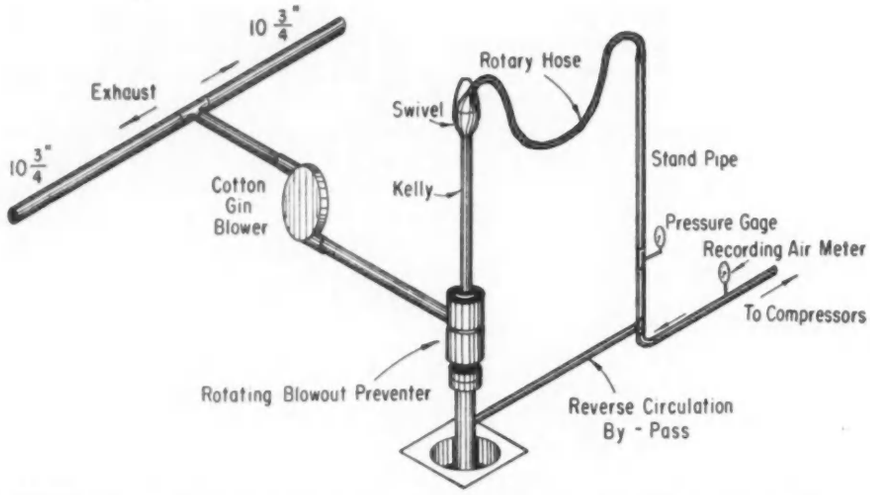


FIGURE 3—This is a schematic of the well connections used on the Cauthorn C-1 and D-1. Note the cotton gin blower that was used in the exhaust line to maintain a slight vacuum on the well annulus and also to purge the exhaust line so that gas would not accumulate around the rig.

tion type compressors of 1000 cfm rated capacity at 100-105 psi were used. These were single stage, 300-hp compressors. The compressors discharged through a 3-inch line into a 4-inch header that was run through the stand by water filled mud tanks to the stand pipe. The water acted as a heat exchanger and cooled the air before entering the stand pipe. A 3-inch high pressure line from a nearby gas well was also connected to the stand pipe. This line was closed off with a valve. In case of compressor failure, the well could be drilled with gas under 500 psi surface pressure. On the B-1, gas was used at 6800 feet because the engines and single stage compressors were at their maximum load conditions at that point, and the gas offered no mechanical problems.

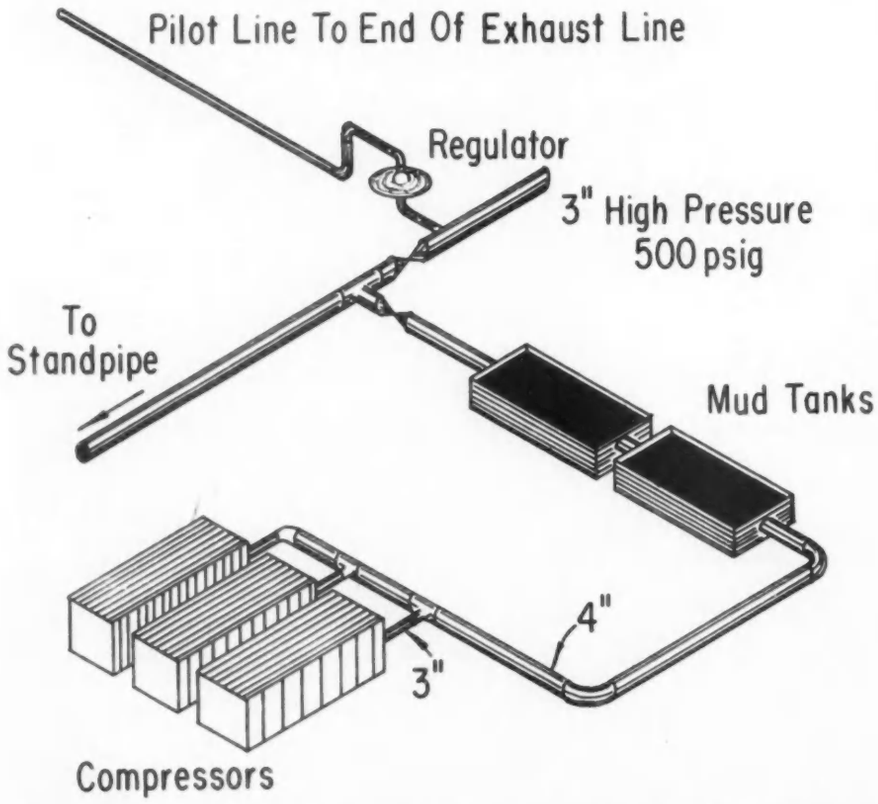


FIGURE 4—The three 1000 cfm compressors that were used on the John Cauthorn B-1 discharged into a 4-inch line that was connected through the water filled mud tanks. These tanks acted as a heat exchanger to cool the compressed air before it entered the standpipe. Note the 3-inch high pressure line that is also connected to the standpipe. This gas supply was a standby but was used below 6800 feet. The 1-inch pilot line from the gas line was strapped to the top of the exhaust line and was used to burn the discharge gases. This was an added safety feature to keep gas from collecting around the rig.

On the C-1 and D-1, a four-cylinder, four-stage, 1500 cubic foot per minute compressor was used (Figure 5). There were no problems in drilling other than keeping the rubbered pipe in the casing.

Drill String Make-Up: The drill strings on the three air and gas drilled wells consisted of a 5¼ inch hex kelly, 5-inch drill pipe, and three 8-inch drill collars and five 7-inch drill collars.

Slotted Liner: Another innovation that proved effective on these air and gas drilled wells was the slotting of the liner on the full closing blowout preventer. The pack-off unit continually filled with fine well cuttings preventing proper functioning of the unit. The inner sleeve of the preventer was slotted with a welder's torch to allow the cuttings to fall out. This worked very successfully and eliminated the trouble that had made it difficult if not impossible to get full closing action on this preventer.

Drilling Program: The short run on the B-1 that went in the hole at 4522 feet and was pulled at 5038 feet was due to a rubber stabilizer body breaking in the hole. The body was over size but was caught on the first trip with a taper tap as there was no fill up and the hole was clean. This would explain the short run received through this section by a carbide type bit. At 5551 feet on the B-1, the rubber stabilizer was removed due to a cracked body. The hole deviation at that time was 1¼ degrees. The hole angle built up from here to total depth even though weight was decreased.

With the carbide insert type bits and drill string stabilizers, 20,000 to 25,000 pounds was run at 80 rpm on the C-1. At no time did the whole deviation exceed ¾ degree from below the intermediate pipe at 1500 feet to 9550 feet, where the hole was mudded up.

The same drilling rig and procedures were used on the D-1 as on the C-1. The bottom hole reamer was laid down at 7728 feet on the D-1 with a hole deviation of 1¼ to 1½

degrees. At 8131 a cross-over sub between the 8-inch and 7-inch drill collars broke. The sub was oversized and a tap was screwed in. The fish was stuck and circulation around the fish could not be broken with 600 psig surface air pressure. The fish was finally pulled loose with 40,000 pounds pull above the weight of the drill string.

From 8000 to 9350 feet the deviation continued to build up even with lighter drilling weights when the bottom hole stabilizer was not in the string.

Figure 6 is a photo of the metal stabilizer that was used on this well. It was fabricated especially for this job because Phillips believed the greater bearing surface of the ribs aided in deviation control.

In the actual drilling operation (Figure 1), the air or gas drilled portion of these holes was approximately 8500 to 8800 feet. The air and gas drilled wells are compared to the initial well drilled in this area, the A-1, which drilled 8802 feet of 8¾ inch hole in 1428¾ hours with 145 bits. This was an average penetration rate of 6.2 feet per hour. Th B-1 drilled 8646 feet in 353 hours with 21 bits, five of which were diamond coring bits, for an average penetration rate of 24.5 feet per hour. Rerun bits were used following the diamond coring to ream the hole out to full gage as a smaller size coring head was used. These bits, where they did not make any additional hole were not counted although the coring time was probably slower than the actual drilling rate would have been. On the C-1, 8674 feet were drilled in 374 hours using only 14 bits for a penetration rate of 23.2 feet per hour.

The D-1 like the C-1 used the larger four-stage compressor rather than the three single stage compressors and 8544 feet were drilled in 388½ hours while using only 13 bits. This was an average penetration rate of 22 feet per hour.

A considerable savings in bits and trips resulted. Only 60.17 feet were obtained per bit on the A-1 as against 657.2 feet per bit on the D-1. On the A-1, the bits rotated only 9.9 hours per bit, as compared to the D-1 where they remained in the hole 29.9 hours per bit. This is a savings of almost 1050 hours between the initial mud drilled well and the gas drilled wells with a further savings of about 130 bits and trips per hole. Some of these savings and added bit life are naturally attributed to the use of carbide insert bits. The longer bit life might be partially explained by the lower drilling weights. However, the air and gas medium must be given due credit.

In the air drilled wells, the B-1 had an average penetration rate of 36.1 feet per hour from the intermediate string to 8700 feet. When it was necessary to mud up from there to total depth the penetration rate was reduced to 3.2 feet per hour. This same fact only in greater magnitude was illustrated on the C-1 and D-1. On the C-1, the average penetration rate from below the intermediate string to 9550 feet was 48.3 feet. From 9550 feet to total depth, the penetration rate was reduced, after mudding up, to 3 feet per hour. On the D-1 it was decided to mud up at 9300 feet. From the bottom of the intermediate string to 9300 feet the penetration rate had been 49.6 feet per hour. Below this point to the total depth, the penetration rate was only 3.3 feet per hour.

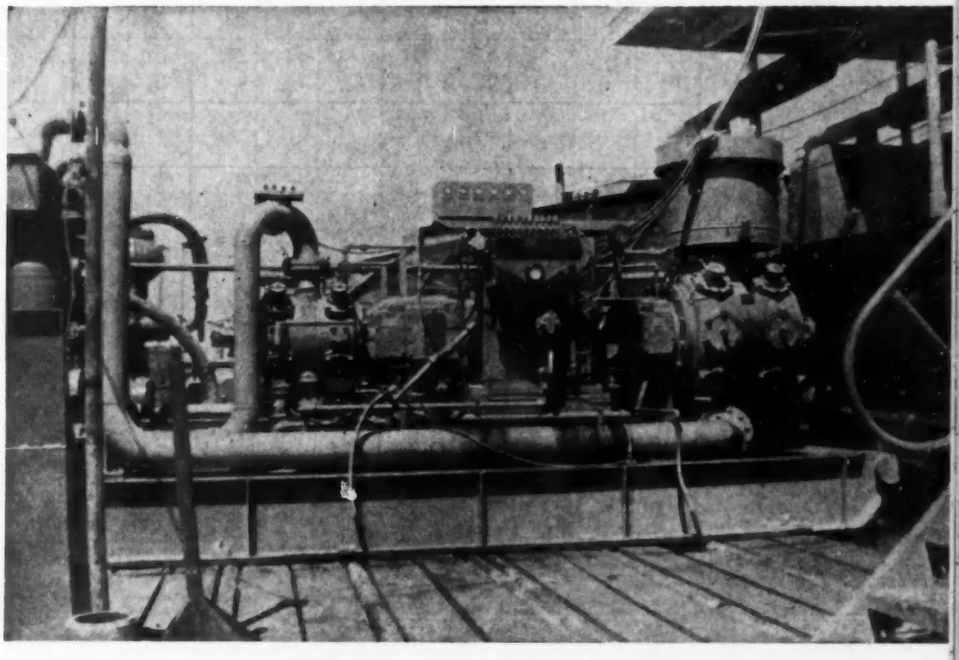


FIGURE 5—This is a side view of the large, 4-cylinder, 1500 cfm compressor that was used on the C-1 and the D-1. This view is of the first and second stages with the heat exchanger barely visible in the left hand side of the picture.

Summary: This is not only a test of air and gas drilling that makes this method stand out completely over the use of heavier drilling fluid columns but it has brought out a number of innovations that will help promote air and gas drilling to an even greater extent. These innovations as mentioned above were:

1. The use of the rig mud tanks as heat exchangers.
2. The use of a cotton gin blower to hold a vacuum on the casing annulus and also to purge the exhaust line.
3. The use of a slotted liner on the full closing blow-out preventer to prevent the accumulation of cuttings and the subsequent jamming of the blow-out preventer.

Other problems were encountered such as the cutting out of the rubber stabilizers due to the high abrasive wear from high velocity sand laden annular air stream. The use of a steel stabilizer at the bit helped to control deviation. Probably further tests will determine whether or not the steel stabilizer will find its place in air and gas drilling for deviation control.

Controlled tests such as these run by Phillips Petroleum will help advance the future of air and gas drilling. These tests, even of a limited nature, are decisive and show the tremendous savings that can be obtained in rig time, trips, number of bits used and wear and tear on the equipment when proper air drilling techniques are used. —**The End**

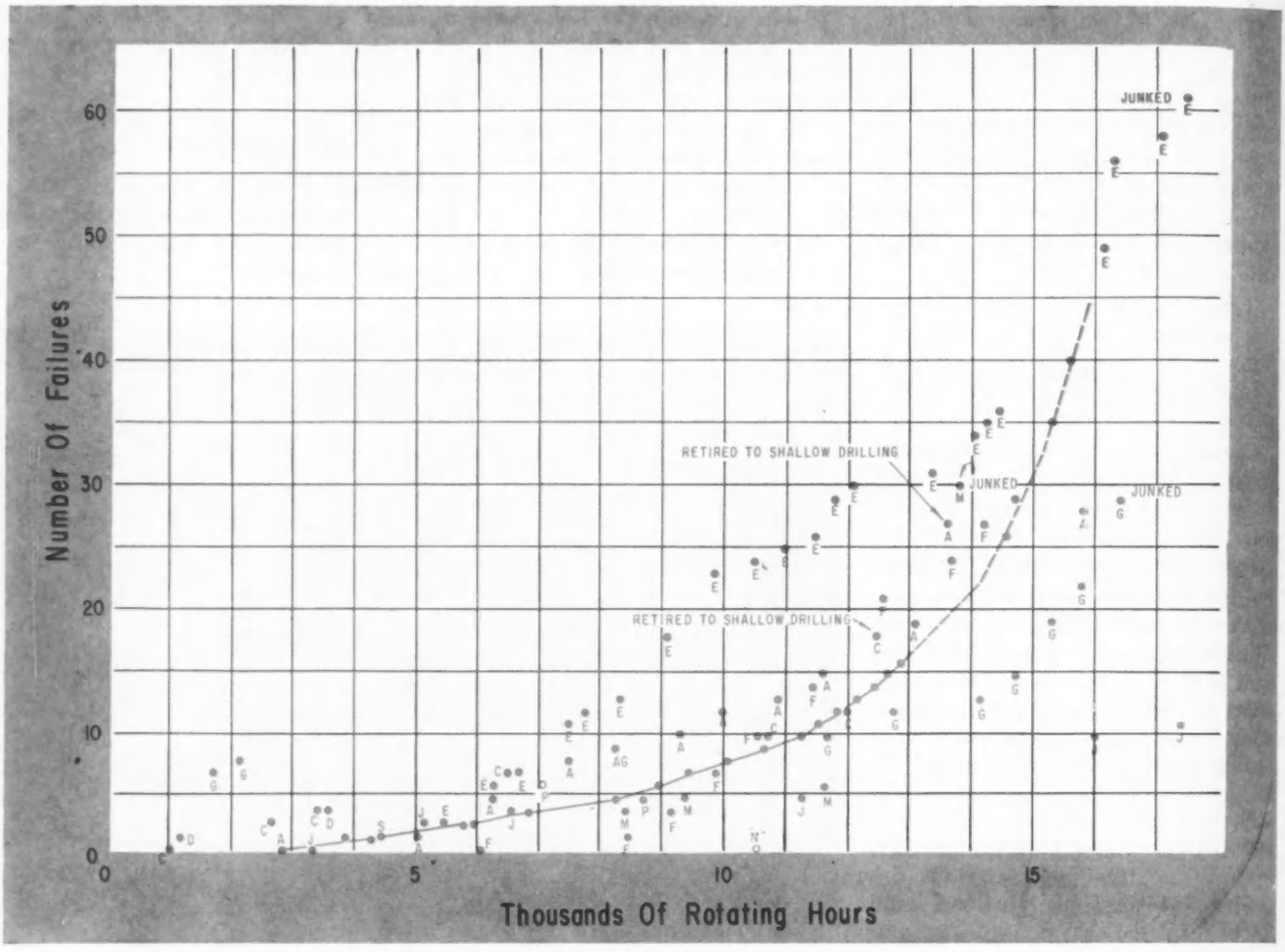


FIGURE 1—Frequency of failure for 3½ inch drill pipe.

What's the Service Life of Drill Pipe?

While difficult to determine, this method provides a guide as to how much service to expect.

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THE SERVICE LIFE expectancy of equipment is necessary data for planning and running any type of business. This is especially true in the drilling business where a miscalculation as to service life can lead to costly shutdowns and even more expensive fishing jobs. There are any number of well planned and accepted preventive maintenance programs in use today. Some of these rely entirely on the experience and judgment of the personnel concerned, others rely on instruments and still others on supervised periodic checks. Other programs are a combination of two or more of the above.

A. W. Thompson, Inc., operating 12 drilling rigs in the Permian Basin has relied on experienced personnel and supervised visual inspection of their equipment. Their program is especially critical when it comes to the drill string itself. Here a rigid program of visual inspection and inventory control give this contractor accurate data as to the service life and failures of his various sizes and types of strings.

As new drill pipe is acquired each joint is marked with a code letter. This has been found to be easier to remember than the manufacturer's designation. A complete service record is then maintained on this string. Transfers of joints to and from this string, and failure records are also maintained. Failure frequency charts are plotted and the life expectancy of each string can be fairly accurately ascertained.

The failure frequency charts have led to certain conclusions, namely: for 3½-inch drill pipe, based on 13 strings of 3½-inch drill pipe—as a string of drill pipe passes 12,500 rotating hours, the frequency increases to one failure for every 200 rotating hours.

By interpolating past 14,000 hours, the frequency increases to one fail-

ure for every 100 rotating hours. By retiring strings of drill pipe to shallow drilling when they reach 12,500 to 14,000 hours, the life of the drill pipe is prolonged and expensive fishing jobs reduced. At the same time it is possible to economically run pipe, at reduced tension loads and vibrations, for a limited period before retiring to junk.

The 4½-inch drill pipe failure frequency charts are based on four strings of drill pipe. The failures were plotted against both footage drilled and rotating hours in an attempt to explain the stepped appearance of the average curves but in both cases this stepped appearance showed. This is probably due to rotating the pipe service; as the number of failures increased, that portion of the string that had been in use was racked in the yard and that which had been on the rack was brought back into service. As in the case of 3½-inch drill pipe, it is recommended that 4½-inch drill pipe be retired to surface hole and shallow drilling after it passes 12,500 rotating hours.

There is no evidence of proof that the strings of pipe that have been sandblasted internally are out performing the pipe which was not sandblasted. It is possible that the service life of the pipe in this report is not far enough advanced to indicate short service life resulting from internal corrosion.

Strings E, G, L and M, involving 1005 joints of drill pipe were retired after an average service life of 5½ years due to corrosion. There is some pipe among the other strings which has not been affected by corrosion to the extent that it is necessary to retire it.

The R string of pipe which is 4-inch O.D. has been temporarily retired.

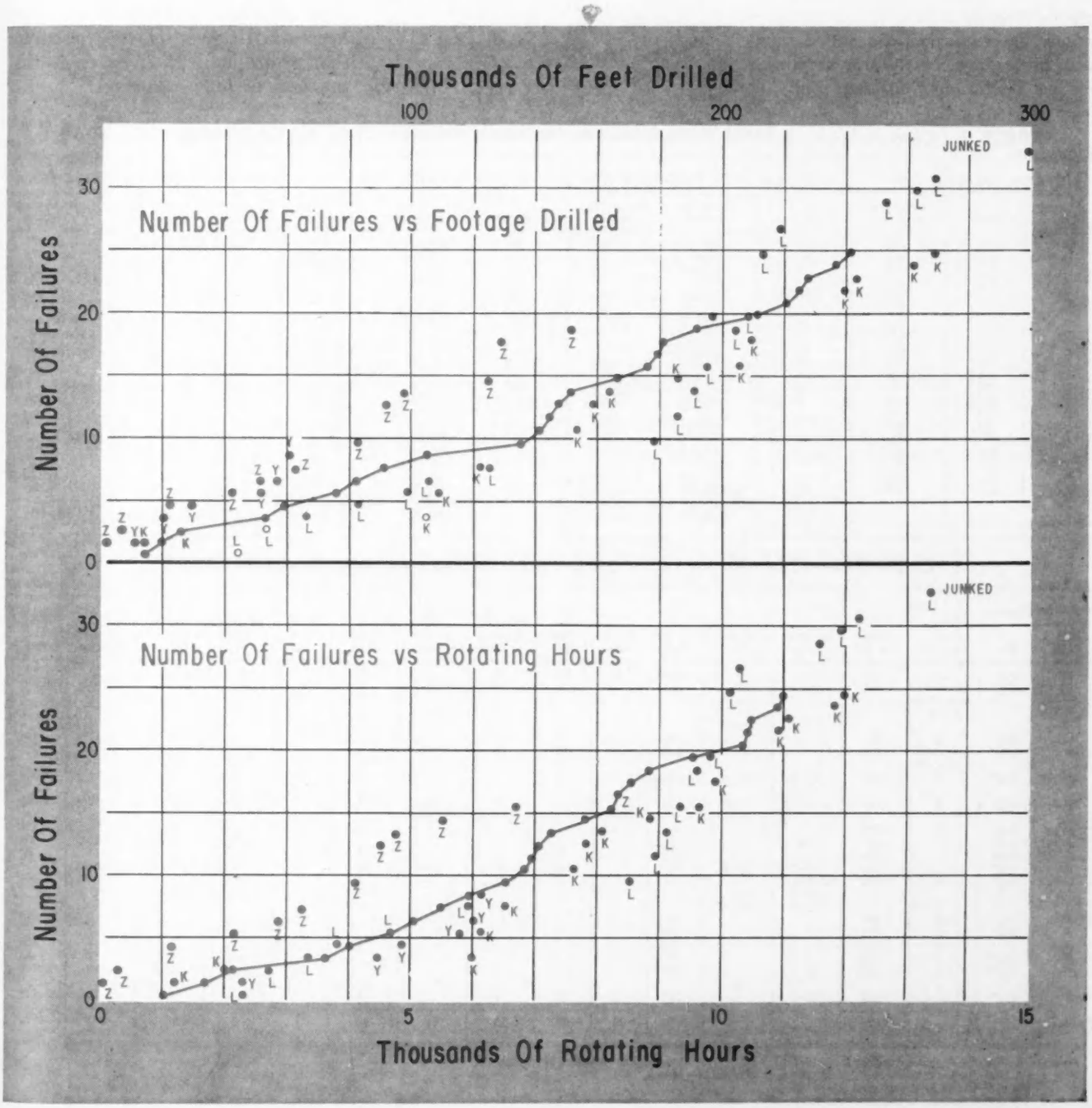

FIGURE 2—Frequency of failure for 4½-inch drill pipe.

According to the mill report this pipe has a low yield strength directly attributed to heavy usage and corrosion fatigue.

The running conditions of the pipe probably have some bearing on its extended performance, but there is no conclusive proof that corrosion is the main cause of pipe failures in the Permian Basin area.

Approximately 224,800 feet of drill pipe rotated 43,131 hours during the 1956 period and drilled 506,809 feet of hole with 111 pipe failures (excluding 1203 joints of culled and junked pipe). Of these operating drill pipe failures only 8.1 percent were twist offs or failures requiring fishing operations. By including the culled pipe, this percentage of failures requiring fishing operations represent only 68 percent of the total. This indicates that careful inspection and observant crews reduced the possible fishing jobs more than 90 percent.

At the close of this period, these strings of drill pipe had rotated a total of 184,901 hours and had drilled 2,015,130 feet of hole.

Failures for the year 1956 breakdown as follows:

Operating Failures

Type of Failure	Number of Joints	Percentage of Failures
Twist Offs While Drilling	9	8.1%
Holes and Washouts Found on Trips	63	56.7%
Mashed in Slips or Bent	10	9.0%
Dropped and Corkscrewed	28	25.3%
Loose Tool Joints	1	0.9%
	111	100.0%

This breakdown covers 111 joints that failed during drilling operations.

This drill pipe maintenance program is carried out by supervised visual inspection and proper service repairs including tool joint repairs and pipe straightening. None of this pipe was inspected by electronic inspection. Operational losses based on a five-year average is $25,000 per year including cost of pipe fishing jobs and the loss of the pipe itself.

It is felt that any operator with proper maintenance of pipe, which will include handling, straightening, joint service work, can normally expect an economical run on deep work. Also after the pipe is retired from deep drilling, it may be used for shallow drilling without excessive fishing jobs or pipe failures.

TABLE 1—Comparison of Total Failures—Accumulative Service Data to September 30, 1956

STRING DESCRIPTION			SERVICE DATA PRIOR TO 1956			1956 SERVICE DATA			ACCUMULATIVE SERVICE DATA		
Co. Code	Size	Original No. Jts.	Failures	Footage Drilled	Rotating Hours	Failures	Footage Drilled	Rotating Hours	Failures	Footage Drilled	Rotating Hours
A	3½"	428	27	88,156	13,470	130	45,181	1,501	157	133,337	14,971
B	3½"	489		New		0	3,937	1,075	0	3,937	1,075
C	3½"	436	7	57,967	9,266	5	19,827	2,622	12	77,794	11,888
D	3½"	453		New		4	23,583	3,470	54	23,583	3,470
E	3½"	440	158	160,676	17,349	282	..	..	440	160,676	17,349
F	3½"	328	15	110,331	11,367	13	20,792	2,714	28	131,123	14,081
G	3½"	395	12	73,276	13,377	336	29,805	2,908	348	103,081	16,285
H	3½"	498	0	14,344	1,722	1	23,925	2,968	1	38,269	4,690
J	3½"	425	41	78,816	12,809	5	22,301	3,091	46	101,117	15,900
K	4½"	338	14	175,127	8,463	9	75,246	2,854	23	250,373	11,317
L	4½"	335	154	309,118	11,970	157	32,382	1,100	311	341,500	13,070
M	3½"	399	20	125,091	10,734	302	46,144	2,988	322	171,235	13,722
N	3½"	408	0	46,950	7,030	1	23,944	3,433	1	70,894	10,463
O	4½"	206				New—Not in service in 1956					
P	3½"	428	1	26,857	3,281	0	14,889	2,432	1	41,746	5,713
R	4"	444	4	32,016	4,579	27	31,851	3,252	31	63,867	7,831
S	3½"	512	2	19,218	4,436	1	16,644	2,860	3	35,862	7,296
X	4"	507		New		0	8,100	1,225	0	8,100	1,225
Y	4½"	295	110	27,389	4,759	5	38,495	1,561	115	65,884	6,320
Z	4½"	192	34	162,989	7,158	36	29,763	1,077	70	192,752	8,235
			599	1,508,321	141,770	1,314	506,809	43,131	1,913	2,015,130	184,901

TABLE 2-A—Cumulative Failure Data on Drill Pipe Through Sept. 30, 1955

String Description																
Co. Code	Size	Pres. Loc. Mar. 56	Orig. No. Jts.	Received From	Sent To	Bal.	Twist Offs	Holes in Pipe Wall	Pitted Slip Cut Mashed or Bent	Dropped and Cork-Screwed	Tool Jt. Wash-Outs	Loose Tool Jt.	Mashed Tool Jt.	Junk. or Misc.	Total Failures	Sept. 1955 Inventory
A	3½"	12	428	21-G	0	449	5	11	9	..	2	..	..	.....	27	422
B	3½"	Junked 9-18-1955 & sold	304	176-10	25-No. 12 15-M 76-F	364	....	....	34	28	5	....	....	297 (a)	364	0
C	3½"	3	436	....	....	436	....	2	4	....	....	....	....	1	7	429
E	3½"	Junked 1-23-1956	440	....	....	440	1	48	1	48	8	....	1	51 (b)	158	282
F	3½"	5	328	25-M 76-B	67-M	362	3	6	....	....	4	....	1	1	15	347
G	3½"	6	395	4-HTC	50-J 21-A	328	....	1	2	7	1	....	1	....	12	316
H	3½"	11	498	....	....	498	....	....	....	....	....	....	....	.....	0	498
J	3½"	9	425	50-G	. .	475	....	....	3	....	....	....	2	36 (c)	41	434
K	4½"	....	338	....	....	338	4	3	4	....	3	....	....	.....	14	324
L	4½"	....	335	16-Y	40-Y	311	10	12	3	....	10	....	....	119 (d)	154	157
M	3½"	8	399	45-Old H 15-B 67-F	25-F 134-No. 12	367	....	1	....	15	4	....	....	....	20	367*
N	3½"	10	408	....	....	408	....	....	....	....	....	....	....	....	0	408
P	3½"	7	428	....	....	428	....	1	....	....	....	....	....	....	1	427
R	4"	2	444	....	....	444	....	2	....	....	1	....	1	....	4	440
S	3½"	4	500	....	....	500	1	....	1	....	....	....	....	.....	2	498
Y	4½"	....	295	40-L	61-Z 16-L	258	....	....	....	....	....	....	....	110 (e)	110	148
Z	4½"	....	192	61-Y	....	253	2	11	1	....	4	1	....	15 (f)	34	219
Totals....	....	....	6593	....	....	6659	26	98	62	98	42	1	6	630	963	5716

Note: A—Retired to shallow drilling 9-17-1955 * 20 Over, Unknown source of surplus
(a) 283—Junked & sold—Sept., 1955; 14 culled to water line March, 1954.
(b) 51—Culled as knotty pipe March, 1954.
(c) 36—Cemented in hole January, 1954.
(d) 8—Unknown 1951; 111 culled as knotty pipe April, May, & Sept., 1954 and Sept., 1955.
(e) 4—Unknown; 77 culled to water line Oct., 1954; 29 Junked Sept., 1955.
(f) 9—Junked when processed March, 1952; 6 culled and junked Sept., 1955.

Pipe reports based upon West Texas operations are not necessarily applicable to Gulf Coast or California service.

Drill pipe in West Texas indicates excessive failures after 12,000 hours of rotation and approximately 100,000 feet of hole. The same rotation in Gulf Coast and California drilling would make 650,000 to 700,000 feet of hole. According to available information, the operators in these areas do not obtain such service life on their drill pipe.

It must therefore be concluded, that pipe records must be confined to a particular area and not set up for any region or nation-wide average.

APPENDIX

A **String Description:** 428 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset, tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "A"), and 21 joints, same description (Marked "GA") added May 9, 1954. 235 joints of original delivery sandblasted internally at the mill and 193 joints shot peened.

Inventory of 9-30-56 is 272 joints.

B **String Description:** 489 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "B"). 251 joints were hardfaced and 254 joints were internally sandblasted.

Inventory of 9-3-56 is 489 joints.

C **String Description:** 436 joints, original string, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D. 3½" I.F. flashweld tool joints (Marked "C"). This string has been neither sandblasted nor shot peened.

Inventory of 9-30-56 is 424 joints.

D **String Description:** 453 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "D"). 233 joints were hardfaced and the entire string was internally sandblasted and shot peened.

Inventory of 9-30-56 is 449 joints.

F **String Description:** 328 joints which originally made up this string were transferred from strings on Rigs #3, 4, 6, and 8 during January of 1953. The joints are 3½", 13.30#/ft., Grade E, Range 2, API external upset tubes with 5" O.D./3½" I.F. double seal shrink grip tool joints (Marked "F"). 25 joints in February and 67 joints in April, 1953, same description joints, were added from "B" string, April 1954.

Inventory of 9-30-56 is 399 joints.

G **String Description:** 395 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "G"). This original shipment was sandblasted internally.

319 joints remaining in this string were junked to water line July 15, 1956.

H **String Description:** 498 joints, 3½", 13 30#/ft., Grade E, Range 2, API external upset tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "H"). These joints were shotblasted internally at the mill and 254 joints were hard banded on the box end only.

Inventory of 9-30-56 is 497 joints.

J **String Description:** 425 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. flashweld tool joints (marked "J") and 50 joints, same description (marked "GJ") added May 9, 1954. The original delivery of pipe was sandblasted internally at the mill.

Inventory of 9-30-56 is 429 joints.

K **String Description:** 338 joints, original delivery, 4½", 16.60#/ft., Grade D, Range 2, Internal Upset tubes with 6" O.D./4½" API Full Hole flashweld tool joint (marked "K") All joints were shotblasted at the mill but none of the joints were hardfaced.

Inventory of 9-30-1956 is 315 joints.

L **String Description:** 335 joints, 4½" 16.60#/ft., Grade D, Range 2, API Internal Upset tubes with approximately 265 joints equiped with 5¾" O.D./4½" API Full Hole double seal shrink grip tool joints and 70 joints equipped with 5¾" O.D. 4½" API Full Hole super shrink grip tool joints (Marked "L" and "LL"). An additional 16 joints of same description tubes were transferred to this string from "Y" string, August 24, 1954.

157 joints remaining in this string were junked to water line Sept. 17, 1956.

M **String Description:** 399 joints which originally made up this string were transferred from strings on Rigs #3, 4, 6, and 8 during December, 1952. The joints are 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. double seal shrink grip tool joints (Marked "M"). 15 joints of same description tubes from "B" string were transferred to "M" string March 1, 1954 and in September, 1955, 67 joints of same description "F" pipe and 20 reconditioned joints from old string were added to "M" string.

277 joints remaining in this string were junked on Sept. 27, 1956.

N **String Description:** 408 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "N"). All tool joints were hardfaced but only 177 joints were shotblasted internally at the mill.

Inventory of 9-30-1956 is 407 joints.

P **String Description:** 428 joints, 3½" 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.F. flashweld tool joints (Marked "P"). These joints were shotblasted internally. 258 joints were hard-faced.

Inventory of 9-30-56 is 427 joints.

R **String Description:** 444 joints, origi-

TABLE 2-B—Failure Data on Drill Pipe During 1956

String Description																
Co. Code	Size	Pres. Loc. Jan. 56	Inventory Sept., 1955	Received From	Sent To	Bal	Twist Offs	Holes in Pipe Wall	Pitted Slip-Cut Mashed or Bent	Dropped and Cork-Screwed	Tool Jt. Wash-Outs	Loose Tool Jt.	Mashed Tool Jt.	Junk. or Misc.	Total Failures	Sept. 1955 Inventory
A	3½"	12	422	....	20-G	402	....	....	....	....	....	....	....	130 (a)	130	272
B	3½"	5	New	....	....	489	....	....	....	....	....	....	....	....	....	489
C	3½"	3	429	....	....	429	2	3	....	....	....	....	....	....	5	424
D	3½"	3	New	....	....	453	1	....	1	2	....	....	....	....	4	449
E	3½"	Junked 1-23-56	282	....	....	282	....	....	....	....	....	....	....	282 (d)	282	Junked
F	3½"	6	347	65-M	....	412	....	13	....	....	....	....	....	....	13	399
G	3½"	Junked	316	20-A	....	336	4	8	4	1	....	....	....	319 (e)	336	Junked
H	3½"	11	498	....	....	498	....	....	....	....	....	....	....	1	1	497
J	3½"	9	434	....	....	434	....	....	3	1	....	....	....	1	5	429
K	4½"	8	324	....	....	324	1	8	....	....	....	....	....	....	9	315
L	4½"	Junked 9-17-56	157	....	....	157	....	....	....	....	....	....	....	157 (d)	157	Junked
M	3½"	Junked 9-7-56	367	....	65-F	302	....	1	....	24	....	....	....	277 (e)	302	Junked
N	3½"	10	408	....	....	408	....	....	1	....	....	....	....	....	1	407
O	4½"	....	New	....	....	206	....	....	....	....	....	....	....	....	....	206
P	3½"	7	427	....	....	427	....	....	....	....	....	....	....	....	....	427
R	4"	Temp. Ret.	440	....	....	440	1	26	....	....	....	....	....	....	27	413
S	3½"	4	498	....	....	498	....	....	1	....	....	....	....	....	1	509*
X	4"	2	New	....	....	507	....	....	....	....	....	....	....	....	....	507
Y	4½"	....	148	....	143-YZ	5	....	4	....	....	....	1	....	....	5	0
Z	4½"	....	219	....	183-YZ	36	....	....	....	....	....	....	....	36 (f)	36	0
YZ	4½"	....	0	143-Y	....	326	....	....	....	....	....	....	....	....	....	326 (g)
			0	183-Z												
		Total...	....	....	....	7371	9	63	10	28	....	1	....	1203	1314	6069
		Percentage based on failure while operating.....					8.1	56.7	9.0	25.3	....	0.9	....	....	....	....
Percentage based on total failures including culled and junked pipe.....							0.68	4.80	0.76	2.14	....	0.08	....	91.54	....	....

(a) 130 joints culled to waterline for excessive wear corrosion 2-15-56.
(b) 282 joints culled for excessive wear 1-23-56.
(c) 319 joints culled for undersize tool joints & corrosion 7-15-56.
(d) 157 joints culled for excessive wear & corrosion 9-17-56.
(e) 277 joints culled for water line for excessive wear 9-7-56.
(f) 36 joints culled for undersize tool joints.
(g) Y & L Pipe combined into one string as of 9-30-56.
*"S" String—12 joints over due to error in previous inventory.

nal delivery, 4" O.D., 14.00#/ft., Grade E, Range 2, API Internal Upset tubes with 5¼" O.D./4" I.F. flashweld tool joints (Marked "R"). These joints were hard-faced on the box end only.

Inventory of 9-30-56 is 413 joints.

S **String Description:** 512 joints, original delivery, 3½", 13.30#/ft., Grade E, Range 2, API External Upset tubes with 5" O.D./3½" I.D. flashweld tool joints (Marked "S"). 153 joints shot-blasted internally at the mill (Marked "SB") and 257 joints hard-faced on box end only.

Inventory of 9-30-56 is 509 joints.

X **String Description:** 507 joints, original delivery, 4" O.D. 14.00#/ft., Grade E, Range 2, API External Upset tubes with 5¾" O.D./4" I.F. flashweld tool joints (Marked "X"). 258 joints were hard-faced. This string was sandblasted and shot peened externally.

Inventory of 9-30-56 is 507 joints.

Y **String Description:** 295 joints, consisting of 260 joints of new pipe and reworked tool joints and 35 joints of new pipe and new tool joints, 4½", 16.60#/ft., Grade D, Range 2, API Internal Upset tubes with 5¾" O.D./4½" API Full Hole single seal shrink grip tool joints (Marked "Y"). An additional 40 joints, same description, were transferred to "Y" string from "L" string, Sept. 17, 1952.

143 joints remaining in this string were combined with 183 joints of "Z" string to form "YZ" string and "Y" string was discontinued in September, 1956.

Z **String Description:** 192 joints, 4½", 16.60 #/ft., Grade D & E, Range 2, API Internal Upset tubes with 5¾" O.D./4½" API Full Hole single shrink grip tool joints (Marked "Z"). 61 joints of same description pipe were transferred to "Z" string from "Y" string, September, 1953.

183 joints remaining in this string were combined with 143 joints of "Y" string to form "YZ" string of 326 joints and "Z" string was discontinued, Sept. 30, 1956.

TABLE 3
Inventory Summary

	Pres. Loc.	1955 Inv. Less Transfers	Failures 1956 Other Than Culling	Culled 1956	1956 Inven.
		3½" DRILL PIPE			
A	12	402	..	130	272
B	5	489	..	....	489
C	..	429	5	....	424
D	3	453	4	....	449
E	Not in Use				
F	6	412	13	....	399
G	Not in Use				
H	11	498	1	....	497
J	9	434	5	....	429
M	Not in Use				
N	10	408	1	....	407
P	7	427	..	....	427
S	4	498	1	....	509
	Total.....	4462	30	130	4302
		4" DRILL PIPE			
R	Temp. Retired	440	27	....	413
X	2	507	..	....	507
	Total.....	947	27	....	920
		4½" DRILL PIPE			
K	8	324	9	....	315
L	Not in Use				
O	..	206	..	....	206
YZ	..	367	5	36	326
	Total.....	897	14	36	847

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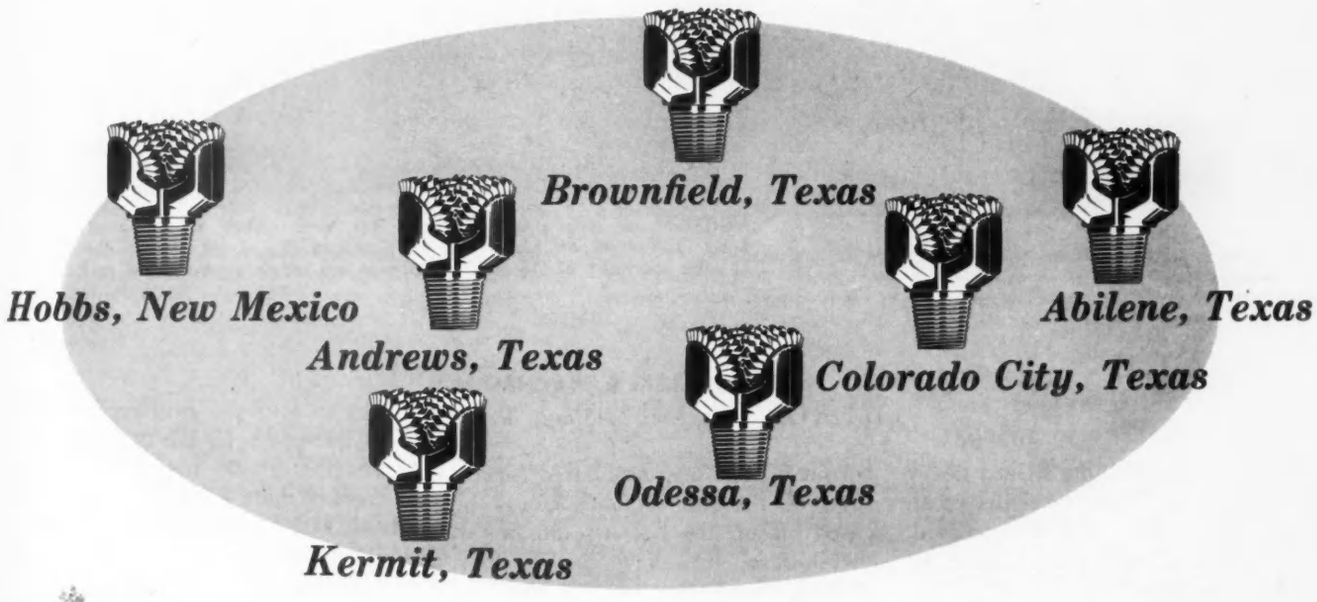

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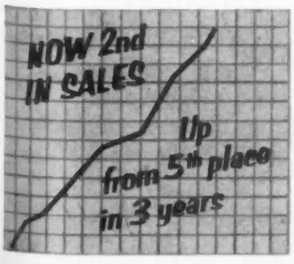

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Drill Collar Practices in Permian Basin

What type and size of joints . . . What O.D. . . . How many? Here are answers to these and other questions.

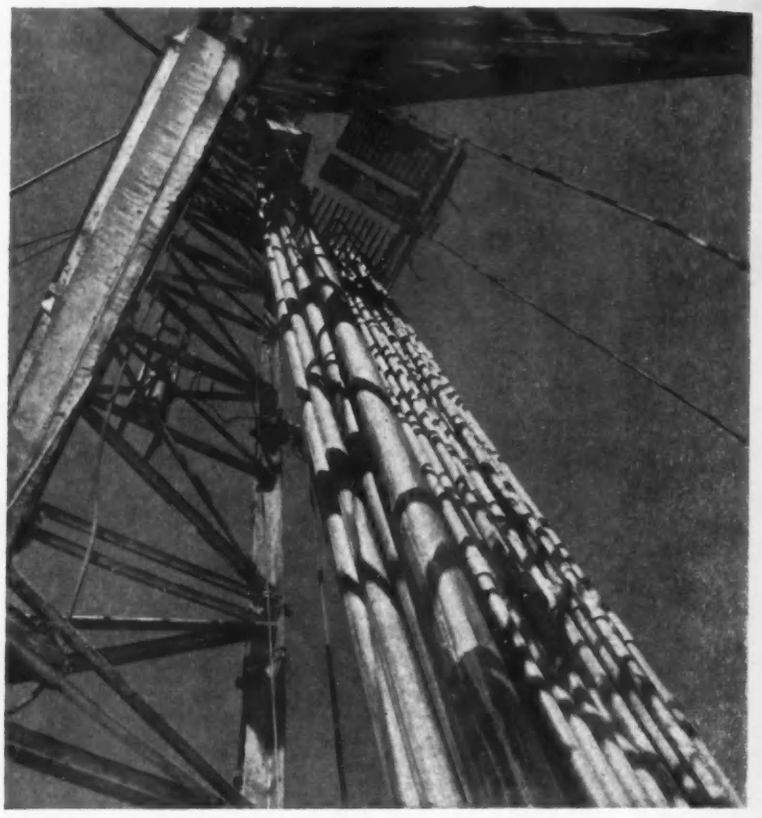

FIGURE 1—A long string of large O.D. drill collars show typical Permian Basin drill stem on Llano Drilling Company Rig 5, in Dora Roberts field, 10 miles southeast of Odessa, Texas. These are widely used in hard rock drilling.

By WILLIAM R. BACHMAN
Drilco Oil Tools, Inc., Midland, Texas

WEST TEXAS drilling means heavy bit weights and heavy weights mean many drill collars. For this reason, long strings of drill collars have become a symbol of West Texas drilling practice, as shown in Figure 1. Just when the practice of adding more weight will stop is difficult to determine, but after ten years contractors continue to add more drill collars to their strings profitably.

Size of Collars. In the early days the size of the drill collars was determined by the use of standard size casing and normal clearances for wash pipe; however, the need for larger O.D. collars has developed new sizes of thin wall washpipes. For example, referring to Table 1, a single 45-foot joint of 7⅝-inch O.D. x 7$^{3}/_{32}$-inch I.D. washpipe is available now to "wash-over" 7-inch O.D. drill collars in 7⅞-inch hole. This is difficult fishing practice and only the hard limestones and dolomites of the Permian Basin permit it. The unconsolidated formations of the salt sections should be cased off up the hole. A number of "wash-over" jobs have been accomplished, however, under "packed hole" conditions.

The limiting factors on size of drill collars seems to be circulation passage in the annulus and build-up of filter cake. At least ⅜-inch clearance is necessary on each side of the drill collars. The maximum collar sizes being used at present are 8-inch O.D. in 8¾-inch hole size, 7-inch O.D. in 7⅞-inch hole, and 6-inch O.D. in 6¾-inch hole. While drilling on bottom the larger O.D. collars are very difficult to stick due to increased velocity of the returning mud and absence of room around the drill collar for cavings to fall in the hole.

From the above discussion it might be concluded that all holes in the Permian Basin are "packed holes." This is not true. Only a small percentage of the contractors use full strings of over-size drill collars in all holes. However, a larger percentage of contractors do use larger collars in crooked hole areas. It is generally felt that the lower 60 to 90 feet of the drill collar string is the critical part of the drill stem in directing and stabilizing the bit. The upper collars merely provide weight to the bit and do not materially affect straight-hole drilling characteristics or stability at the bit. The most common practice is to run two to six large collars on bottom and stack smaller drill collars on top. This involves the minimum "wash-over" risk for the large collars. A typical string of this type would be two 7-inch O.D. on bottom and 18 6¼-inch O.D. drill collars on top in a 7⅞-inch hole. This provides a stiffer, better stabilized section at the bit while providing a safe string to "fish for" on top. Surprisingly enough, it is extremely rare that a couple of large collars are stuck on bottom after washing over the small drill collars on top.

It is interesting to note that on an average, drill collar connection troubles decrease as the collars fit the hole

FIGURE 2—Good care and operation procedure has helped reduce drill collar costs on deeper Permian Basin wells from $700 to $200 per rig per month.

FIGURE 3—Torque indicator being installed in back-up line on A. W. Thompson, Incorporated, Rig 8, Spraberry field. This "tripping type" gives "loud report" when proper pull is applied to tong collar torque indicator.

closer. As most West Texas joint failures are a result of cracks due to bending fatigue, the decreased bending in the packed holes results in a decided improvement in connection life.

Drilling Weights and RPM. A survey of most of the deeper rigs in the area indicates the present length of collar strings to be 20 to 22 drill collars. Where older worn collars are used above several larger collars on bottom, more collars may be run. However, the value of more weight per collar, providing more weight closer to the bit and less joints in the string, strongly favors the use of larger drill collars. This would retire worn collars to use in smaller size holes or for resale in areas outside the Permian Basin.

Many different weights have been run on bits in the hard rock country. The limit of weight depends on how destructive the formation is on bit teeth and bearings. Averages of weight on the bit for the deeper areas fall in the following general ranges:

8¾" hole ..... 60,000 to 65,000 lbs.
7⅞" hole ..... 50,000 to 55,000 lbs.
6¾" hole ..... 45,000 to 50,000 lbs.

TABLE 1—Drill Collar "Wash-Over" Data. West Texas - New Mexico. May, 1957.

Hole Size	Drill Collar Description	Drill Collar O.D.	Washpipe Size–Weight	Overshot Size–O.D.
8¾"	Conventional	7"	8⅛" O.D. x 7 1/16" I.D.—39 lb.	8½" (8⅝" F.S. Turned on O.D.)
	Large Collars	7½"	8⅛" O.D. x 7⅝" I.D.—44 lb.	8⅝" S.H.
	"Packed-Hole"	8"	8⅝" O.D. x 8⅛" I.D.—24 lb.*	None
7⅞"	Conventional	6"–6½"	7" O.D. x 6 31/32" I.D.—26 lb.	7⅝" F.S.
	Large Collars	6½"	7⅜" O.D. x 6⅝" I.D.—28 lb.	7⅝" S.H.
	"Packed-Hole"	7"	7⅝" O.D. x 7⅛" I.D.—20 lb.*	None
6¾"	Conventional	5¼"	6" O.D. x 5 11/16" I.D.—20 lb.	6⅜" S.H.
	Large Collars	5½"	6⅛" O.D. x 5⅝" I.D.—24 lb.	6⅝" S.H.
	"Packed-Hole"	6"	6⅝" O.D. x 6⅛" I.D.—17 lb.*	None

1. * Special long single joints for "washing-Over" one drill collar at a time.
2. Overshot types—F.S.—Full Strength.
S.H.—Slim Hole.

The rpm of the string is limited by the number of drill collars and the life of the bit bearings in the formation being drilled. For the weights listed above, an rpm of 60 to 70 would be an average for most of the deeper drilling. Drill collar joint failures become quite high if a faster rpm is used. This is due to the increased flexing of the string when the bit does not drill off rapidly in the harder formations.

Drill Collar Connections. Repair costs on drill collars have decreased greatly in the past eight years. In 1949 it was estimated that the drill collar shop costs in the 7000-foot or deeper drilling were $700 per rig per month. Today the figure is about $200 per rig per month. This amazing reduction is a result of a number of factors.

The first major reduction in drill collar joint costs is due to better care and operation in making-up and breaking-out the joints in the field, as shown in Figure 2. It is interesting to note that about one-fourth of all the drilling rigs in the Basin now use some type of drill collar torque

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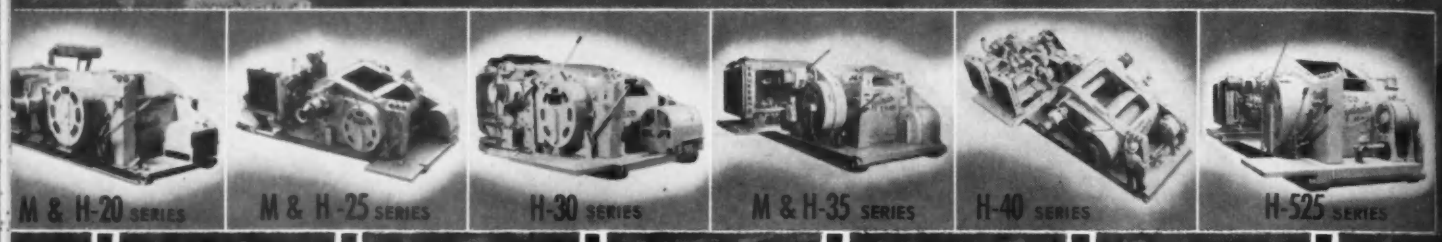

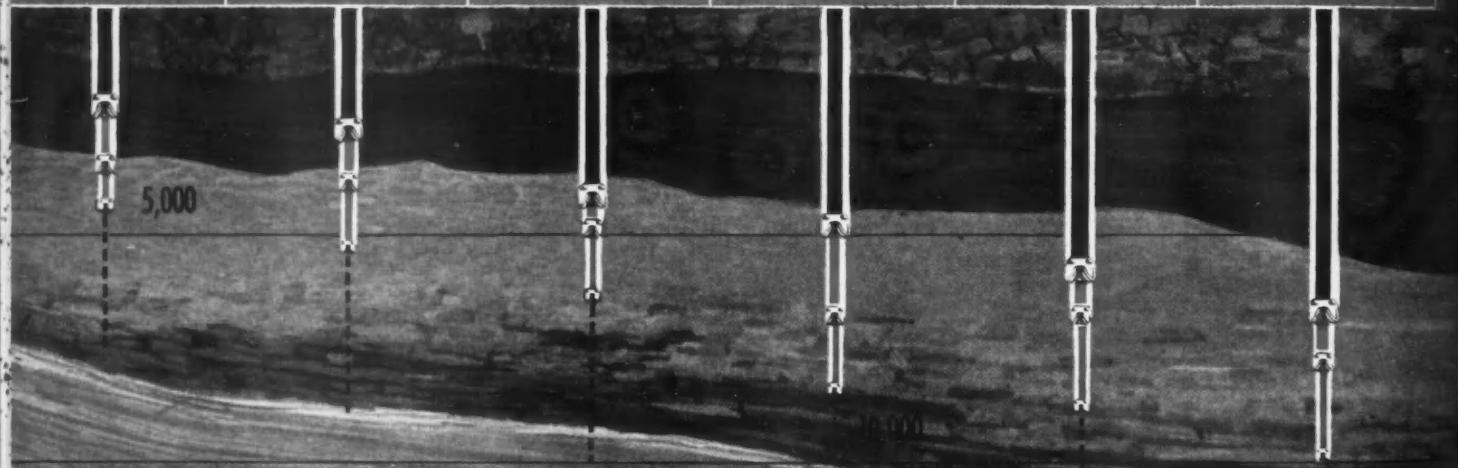

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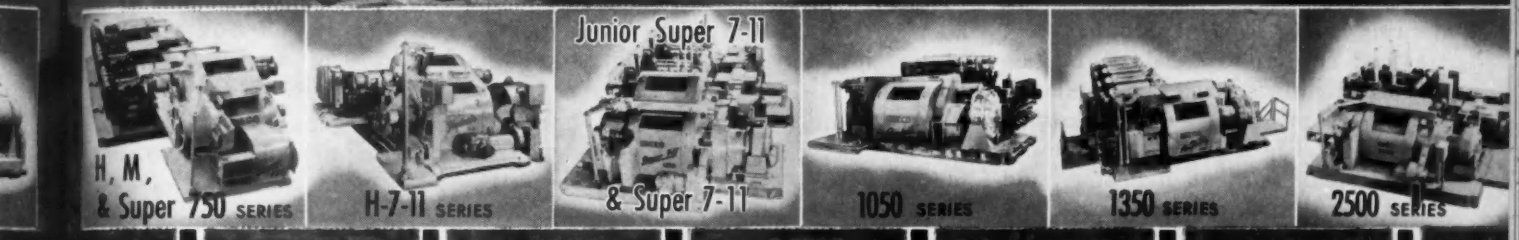

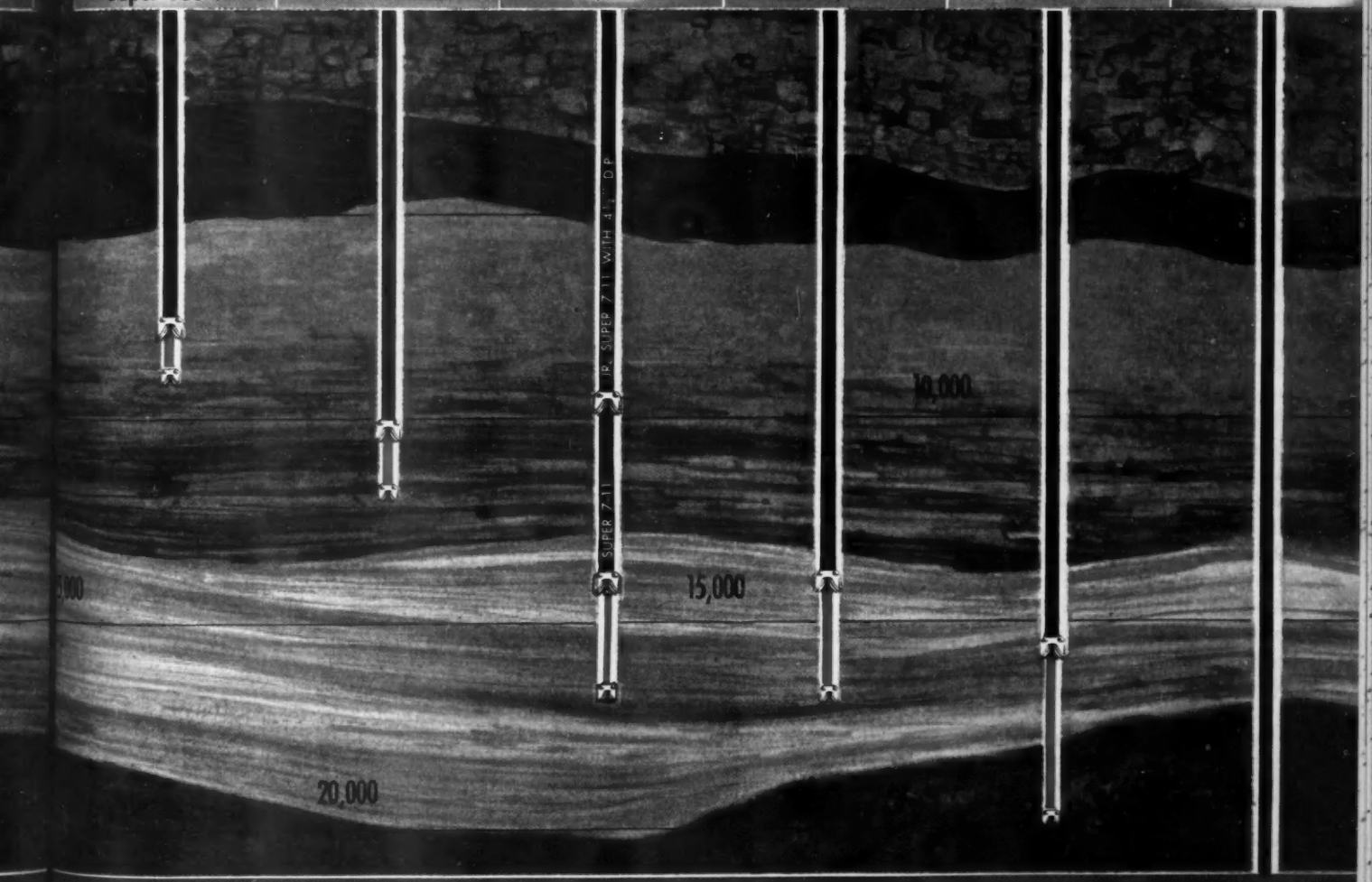

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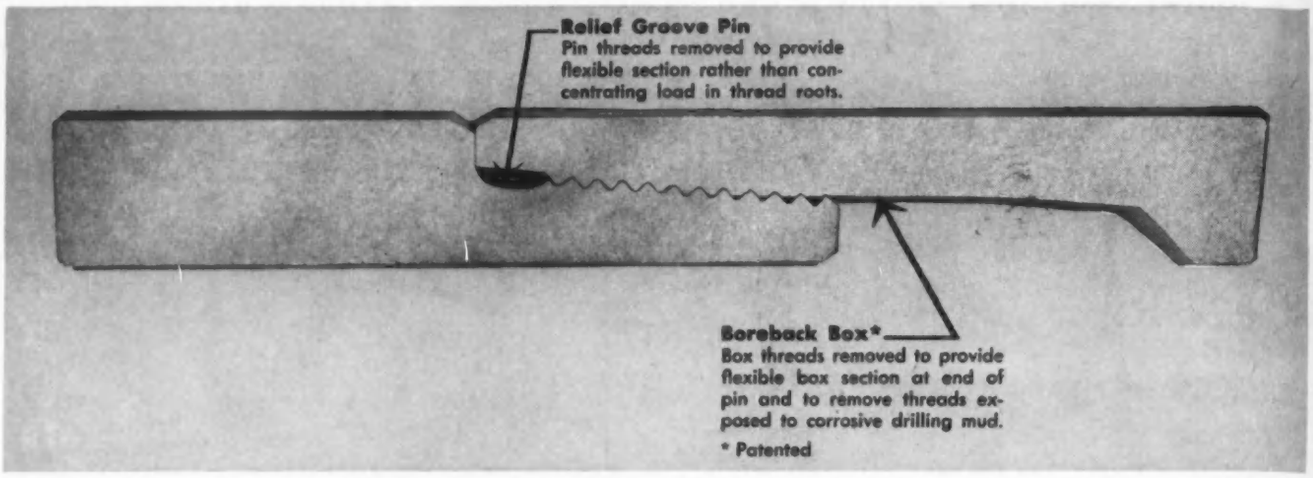
Relief Groove Pin
Pin threads removed to provide flexible section rather than concentrating load in thread roots.
Boreback Box*
Box threads removed to provide flexible box section at end of pin and to remove threads exposed to corrosive drilling mud.
* Patented

FIGURE 4—Half cross-sectional view of an H90 pin by box connection showing relief grooved pin and bore back box. This type of stress relief increases resistance to fatigue and is being used widely in West Texas.

indicator. There are three types presently commercially available: (1) a spring loaded toggle device that gives a loud report to the driller when proper tightness is reached, similar to a set of miniature jars releasing, shown in Figure 3; (2) a regular spring scale with an indicator hand that points to a calibrated scale; and (3) a hydraulic gage with cylinder that also uses a calibrated scale.

Operating personnel now have a much better understanding of why drill collar joints gall or wash-out. In practice if a joint is made-up to the proper tightness, it should break-out within about 10 percent to 20 percent of the torque used to make it up. If too little make-up torque is used, the shoulders leak, washing out the dope; consequently the joints require two to three times more torque to break-out than to make-up due to the increase in co-efficient of friction on the dry shoulder surfaces. As dry surfaces are also likely to seize, not only washed-out joints but also galled shoulders occur from too little torque. It can be noted on bad galls on shoulders that the metal is generally "rolled up" in the break-out direction, not the make-up direction. In a properly machined and doped joint, excessive torque merely stretches threads and swells boxes but does not usually cause galled shoulders and broken threads. A more general knowledge of causes of troubles such as this has done much to increase joint life.

When joints are properly made-up, the foremost enemy of drill collar joints in West Texas then becomes cracking due to fatigue. Relief groove pins and "boreback" boxes, as shown in Figure 4, have done much to increase resistance to fatigue cracks. These stress relief features do not affect interchangeability with standard joints. The groove on the pin removes the highest stress point from the root of threads near the pin shoulder and places this stress on a smooth reduced section adjacent to the pin shoulder which can bend slightly without concentrating the stress in thread notches. This provides the pin with greater flexibility and minimizing the danger of cracking.

Fatigue cracks in boxes are due chiefly to two causes: (1) stress concentration in the roots of the threads in the box at the end of the pin, and (2) corrosion in the box thread roots exposed to the mud. The "boreback" is a long flexible cylindrical section cut in the back of the box to prevent concentration of stress on the box threads at the end of the pin and to eliminate from the box all threads which would otherwise be exposed to corrosive mud. If the connection is doped properly, all box threads should be full of dope and covered by the pin threads.

It is not uncommon for drill collar joints to last 4000 to 5000 rotating hours when using these new joint designs, torque indicators, and good rig practice.

It is interesting to note that 60 to 70 percent of the connections in West Texas are now H90. The success of the H90 in replacing API joints can be attributed to several factors. The flatter thread appears to take more rig abuse and still make-up properly. The cold-rolling specified to be used with this thread increases the resistance of the joint to fatigue cracking. In fact, many consider that a great deal of the success of the H90 is due to cold-rolled threads. A number of the contractors using API threads use some form of cold work on the thread roots also. Either hi-flexing, cold-working the thread roots by peening, or cold-rolling tools with formed rollers are used.

Connection size versus drill collar size in West Texas shows that the connections are about one-half size smaller than most other areas. For a given size collar this provides a stronger box relative to the pin. To provide strength for the smaller pins, smaller bores are generally used throughout the area. A typical joint program is shown in Table 2. Many variations in this joint program occur due to cost of changing from larger to smaller size joints as the collars wear on the O.D. However, these are ideal sizes for hard rock drilling and

TABLE 2—Typical Drill Collar Joint Programs for West Texas - New Mexico, June, 1957.

API THREADS			H90 THREADS		
	Drill Collar Size			Drill Collar Size	
Joint Size	O.D.	Bore	Joint Size	O.D.	Bore
6⅝ Reg.	7¼" to 8"	2¾"	6⅝ H90	7¼" to 8"	2¾"
4½ IF	6½" to 7¼"	2¼"	5 H90	6⅜" to 7¼"	2¼"
4½ XH (4 IF)	6" to 6½"	2¼"	4 H90	5½" to 6⅜"	2¼"
4 FH	5¼" to 6"	2¼"	3½ H90	4¾" to 5½"	2"
3½ IF	4¾" to 5¼"	2"			

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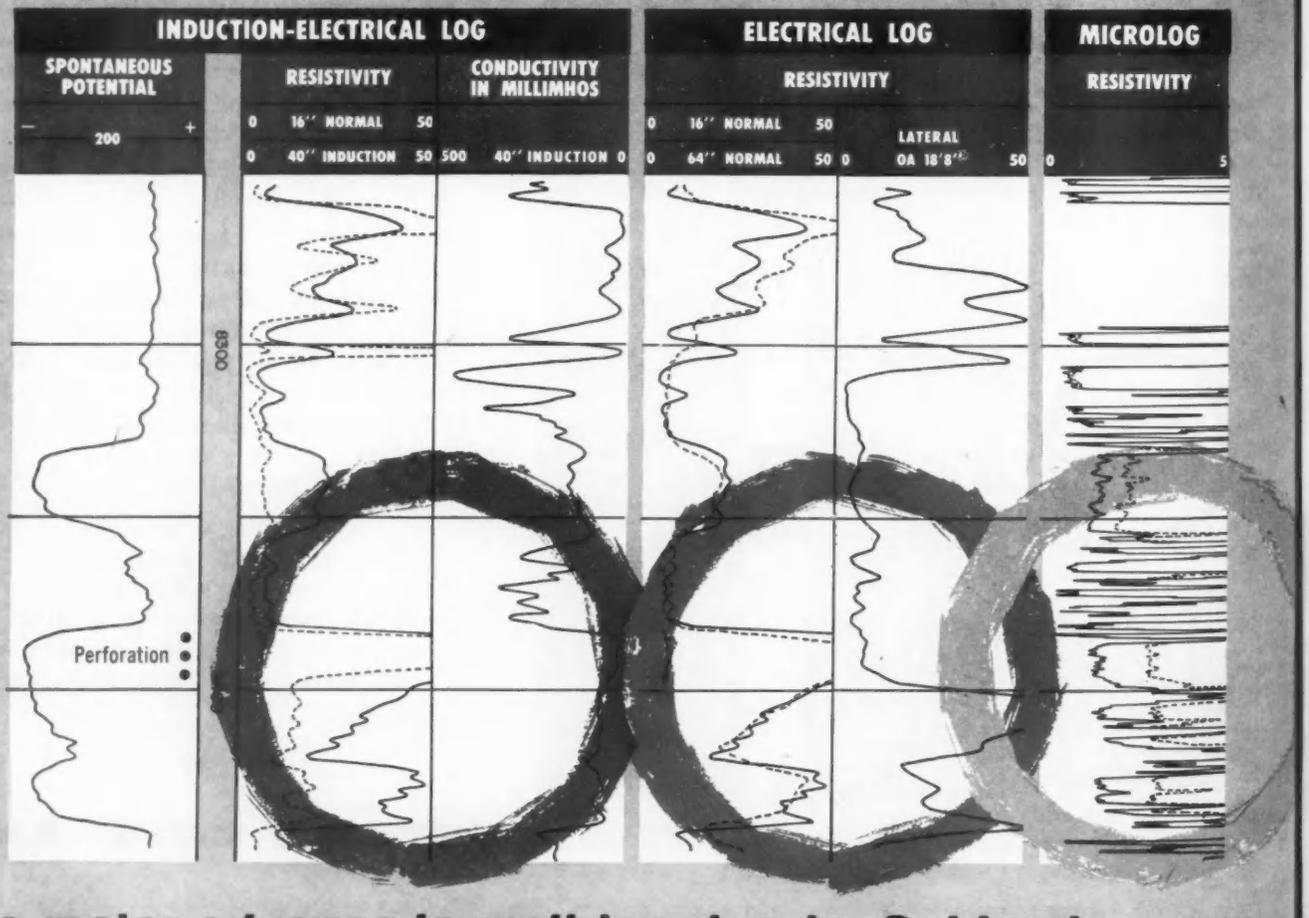

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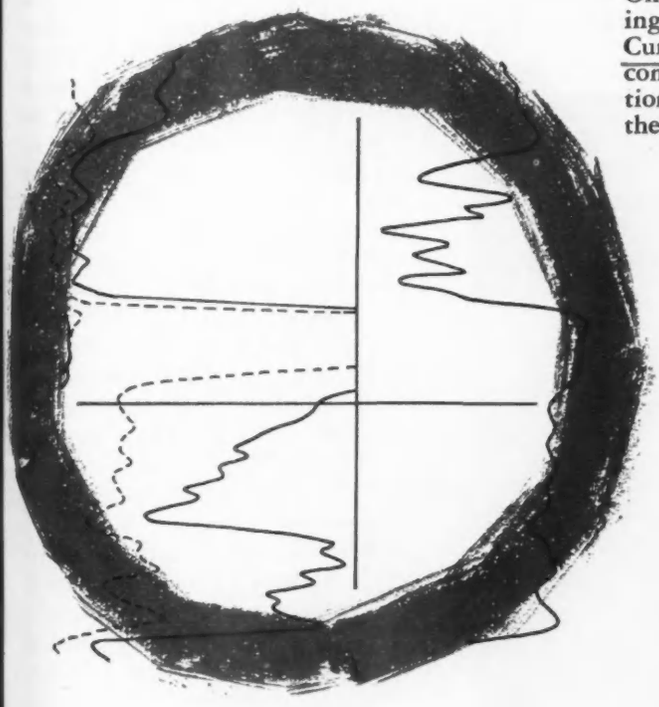

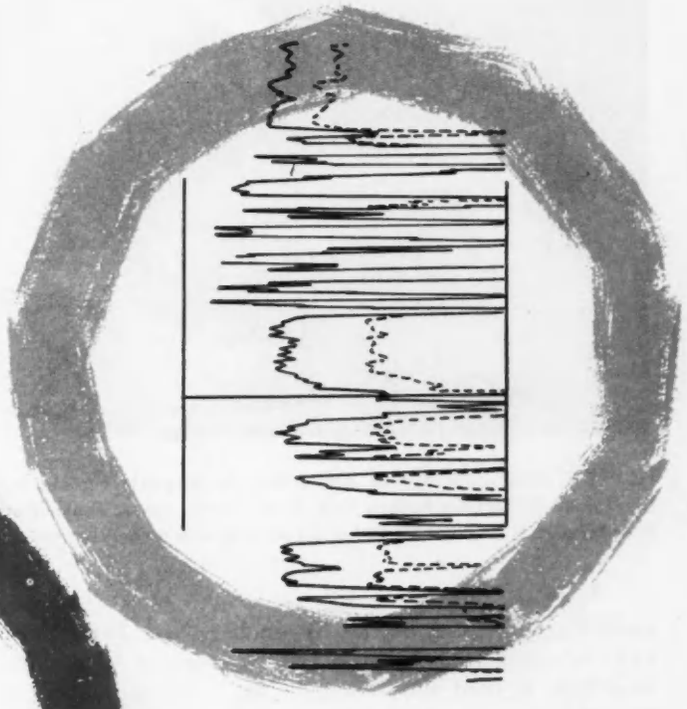

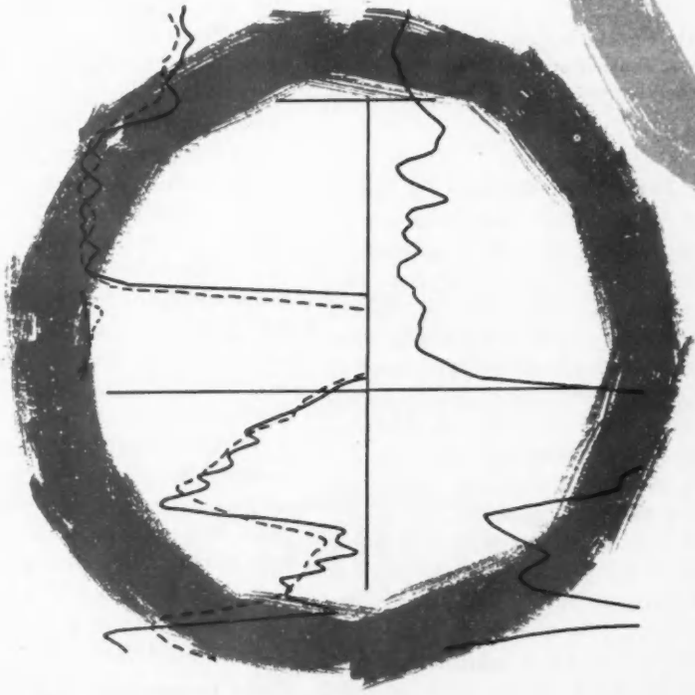

The high readings on the Short Normal and Long Normal Curves are the result of invasion. The lateral curve does not show the productive section at the top of the bed due to its characteristic lag. The lateral also gives high readings and misses the water in the lower section because of numerous hard streaks as shown by the MicroLog.

offer a selection of joints to cover all sizes from 4¾-inch O.D. through 8-inch O.D. By using this guide, the entire range of drill collars normally used in West Texas drilling can be covered by use of five sizes of API joints or four sizes of H90 joints.

Step-Boring and Lengths of Drill Collars. To provide good hydraulics through the drill collar string and still maintain a small bore in the pin, the practice of using step-bore drill collars is becoming more popular in the Permian Basin. This practice is particularly helpful in the 6½-inch O.D. to 7-inch O.D. size where a 2¼-inch bore is used for 3 feet on the pin end, and 2¾-inch bore is used for the remainder of the collar. When pumping 400 gallons per minute through 400 feet of collars, the use of a 2¼-inch-2¾-inch step-bore collar reduces hydraulic losses to about one-half of the loss occurring in a straight 2¼-inch bore collar. The penalty for loss of weight is quite small, only seven pounds per foot in the 2¾-inch bore section.

In the Permian Basin, frequent cutting of connections decreases the drill collar length. To offset this loss of length most of the drill collars now being delivered are 31 feet long. This additional foot of drill collar length on the new collar costs less than the price of the material stub-welded to the end of the collar at a later date. A rule of thumb for O.D. wear rate for the entire West Texas area is about ⅛-inch to 3/16-inch per year. Consequently, with good rig practice, it should be possible to wear a 7-inch O.D. x 2¼-inch bore drill collar to 5½-inch O.D. to 5¾-inch O.D. before stubbing. The collar could then be stub-welded with 2-inch bore stock, the joint size reduced, and used in 6¾-inch holes.

FIGURE 5—Field inspection of drill collars by magnetic particle method on Zephyr Drilling Corporation Rig in Dora Roberts field, Ector County, Texas. Approximately 85 percent of all rigs in Permian Basin drilling 7000 feet or deeper holes now use some connections to prevent fishing jobs.

New Type Drill Collar. To reduce initial drill collar costs, the use of substitute materials for a substantial portion of the drill collar has been investigated and looks promising. Field practice with drill collar joints has indicated that it is imperative to have chrome-molybdenum or equivalent alloy steel ends on the drill collars to give satisfactory joint life. The center section of the drill collar presents a different problem. It is subjected only to compressive and bending loads far below the yield point of the steel, and these requirements can be met by a cheaper grade steel. The answer to making a satisfactory drill collar by putting the type of steel necessary to perform a satisfactory job in the right place is a result of developing improved welding methods. By welding high-cost alloy ends for the joints on to lower-cost heavy wall rolled and pierced drill pipe steel for the center section, a collar can be made that will give performance equivalent to full length alloy collars for a greatly reduced price. For example, the price per pound for 7-inch O.D. drill collars is reduced from approximately 36 cents per pound to 26½ cents per pound according to new Composite Catalog prices. The first 60 of these new type drill collars were made and run in the hole in hard rock country three years ago. A year ago, after two years of field observation, the collars were placed on a production basis. There has been no greater wear on the drill pipe steel center section than on the alloy ends. A more recent 7-inch O.D. string was dropped due to drill pipe failures in both 12¼-inch and 17½-inch holes. Some spiralling of the drill collars occurred; however, the condition was not particularly abnormal to full length alloy collars dropped under the same conditions. In both cases all collars were successfully straightened and returned to service.

It is interesting to note the differences in repairing dropped strings of the welded tube and full length alloy collars. In the tube collars most of the bending occurs in the drill pipe steel in the center section with the joints remaining in alignment with the alloy ends. Very few joints have to be recut due to joint misalignment after straightening. With the full length alloy collars, a much larger percentage of joints have to be recut to restore alignment because the joints constitute the most flexible point in the alloy collar. The larger number of joints recut on an alloy string approximately equals the additional straightening cost on the tubes. As closely as can be determined at present, there is not a cost advantage in favor of either collar when repairing a dropped string.

When related to the entire drilling string, the tube-welding idea is not particularly new, as high-cost alloy steel tool joints are welded on low-cost carbon steel drill pipe; however, the application of this idea to drill collars appears to provide a real saving in initial drill collar costs.

Field Inspection. Field inspection of drill collars (Figure 5) continues to

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FIGURE 6—Grinding bevels on drill collar connections, a part of the drill collar field inspection job, removes sharp "fins" from shoulders. Many times these metal particles will become lodged between shoulder faces causing "galls" and "washouts" if not removed between wells.

become more widely used. This service is a means of preventing fishing jobs and reducing the number of connections shopped by repairing damaged connections at the rig while the damage is still minor. The percentage of rigs using some type of magnetic particle inspection is approximately 85 percent.

It is the general practice to inspect the collars after each 5000 to 6000 feet on deeper holes. On 12,000 to 14,000 foot holes, several contractors inspect on a "trip job" at about 10,000 feet. On shallow holes less than 5,000 feet, many rigs drill three to six holes between inspections. The frequency of inspection can best be determined by the individual contractor. If he fishes during a well, the period between inspections should be decreased. If all his drill collars are "OK" after inspection, the period should be increased. High rpm and longer strings of collars cause more cracked joints, hence more frequent inspections. Fatigue cracks are progressive in nature. The important point is to determine how fast cracks propagate so they may be detected before actual failure.

Salvage work on drill collar connections with hand tools at the rig can save many dollars. By using a simple shoulder refacing tool a "washed" shoulder can be dressed before it reaches the shopping stage. Lack of bevels on joints can cause "fins" from the mating joint to become lodged between the shoulders, precipitating galls and washes. These bevels can be restored simply by use of hand grinders, as shown in Figure 6.

Fine hair-line fatigue cracks in the thread roots gradually develop into full-grown fatigue breaks. In 1949 the practice of forming a grinding wheel to the shape of a thread root was first begun. By grinding and polishing the thread root, the beginnings of the fatigue cracks can be removed.

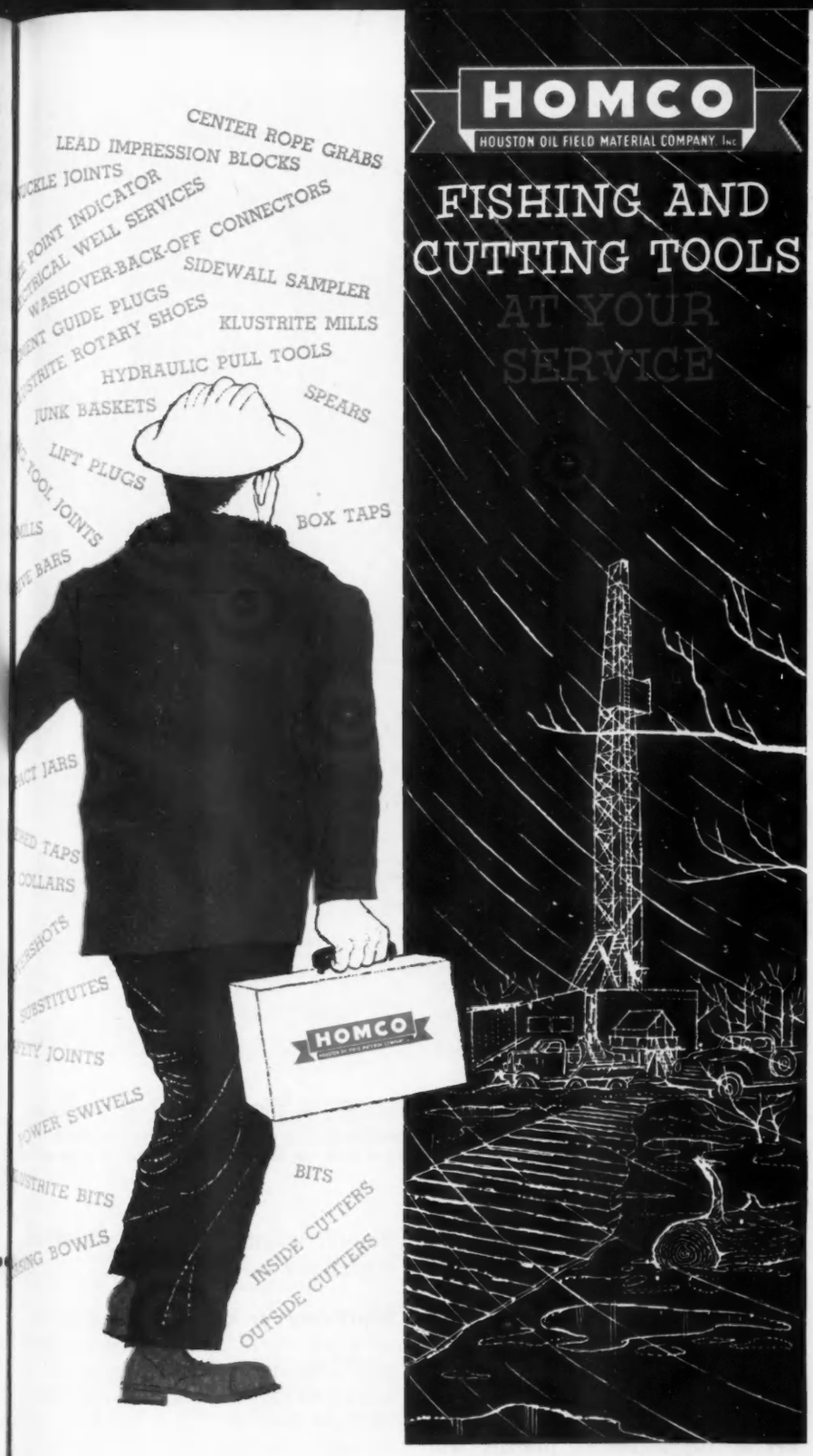
The basis for grinding out fatigue cracks was derived from available laboratory data on fatigue test specimens. These data showed that once a crack began, it progressed rapidly; but if it was removed to a depth of only a few thousandths of an inch under the root, the parent material was not appreciably damaged in fatigue strength.

The value of grinding out cracks in the field was clearly demonstrated several years later on a rig owned by one of the major companies drilling in the Denton Pool. After the first 10,000-foot hole there were several fine hairline cracks that developed in the thread roots on a new string of drill collars. These cracks were ground out and the thread roots polished. On the second 10,000-foot hole one of the repaired connections was shopped; however, some of the repaired connections were still running at the end of the eighth 10,000-foot hole. Had the repair work not been done in the early life of the cracks, the connections undoubtedly would have failed long before the eighth well.

Prior to field inspection, some contractors used the practice of sending entire strings of collars to the shop after a certain number of wells or after fishing jobs became frequent. The practice of separating good from bad joints and shopping only those known to be cracked or damaged has been an important factor in reducing drill collar costs per rig per month in recent years. —**The End**

About the Author

WILLIAM R. (Bill) Bachman, general sales manager of Drilco Oil Tools, Inc., of Midland, Texas, attended T.C.U. in 1939-1941 and the Univerversity of Texas in 1946-1948 where he was graduated with a degree in mechanical engineering. He was a research engineer with Hughes Tool Company in Houston for three years working on drill collar and tool joint problems. He worked for a year with Security Engineering Company as Mid-Continent regional engineer and moved to Midland in 1952 to help organize and operate Drilco Engineering Co., a predecessor of Drilco Oil Tools. He is a registered professional engineer in Texas and a member of API, AIME and ASME.



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Progress at SACROC

SACROC is the largest pressure maintenance project ever attempted as well as the largest unit ever formed. It covers 49,534.2 acres in Scurry County, Texas; is almost 17 miles long and from 4 to 7 miles wide with a nearly horizontal water-oil contact under the entire field. Performance since the initial injection in 1954 indicates the operation to be successful. Much of this success is the result of close cooperation between working interest owners, royalty owners, segment operators, the unit manager and the Texas Railroad Commission. Over 99 percent of the working interests and royalty interests are a part of the unit, approximately 2700 owners. The state's transfer of allowables also plays an important part in SACROC's success. Here is working proof that unitization can be successful and mutually advantageous on a large scale. This project already has accomplished a great deal and in the remainder of its 50-year life span will accomplish much more.

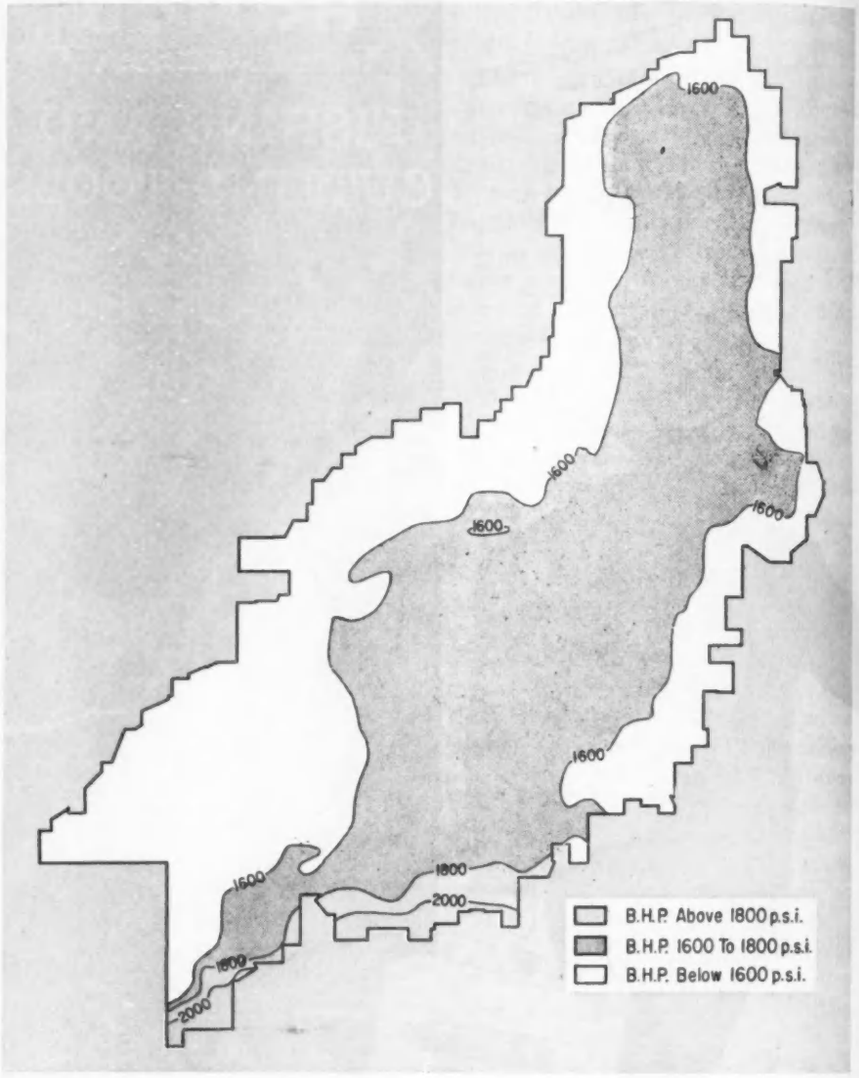

FIGURE 1—By July 1954, the bottom-hole pressures facing the SACROC unit in the Kelly-Snyder field had dropped considerably from their original magnitude. This contour map illustrates the situation at the time that the center-to-edge water injection plan was instigated in the 49,534-acre unit.

WITH EXPLORATION and drilling costs on the increase and fewer prolific wells being discovered, more operators are taking a closer look at secondary recovery and pressure maintenance. It is often less costly to go where you know there is oil and attempt to recover additional quantities by supplementing primary with secondary recovery methods rather than to attempt to discover new fields. SACROC Unit became effective on March 1, 1953 and started pressure maintenance in the fall of 1954. Reservoir conditions in the Kelly-Snyder field have been vastly improved by the pressure maintenance program and the results being achieved closely parallel the predictions made for the project. A close look at the operation today shows that the $7½ million pressure maintenance project is off to a good start.

Kelly-Snyder Unitized. Unitization as a prelude to pressure maintenance and secondary recovery presents a multitude of problems, but what large venture does not. The problems involved in the formation of SACROC, both technical and managerial, were discussed in "The SACROC Story" in WORLD OIL, May 1955. How is this project doing today? Let's take a look.

The 49,500 acres in the field are divided into three parts. The northern Segment, Number 1, is operated by Standard Oil Company of Texas, Segment 2 in the central portion of the field is operated by the Magnolia Petroleum Company and Segment 3 in the south portion of the field is

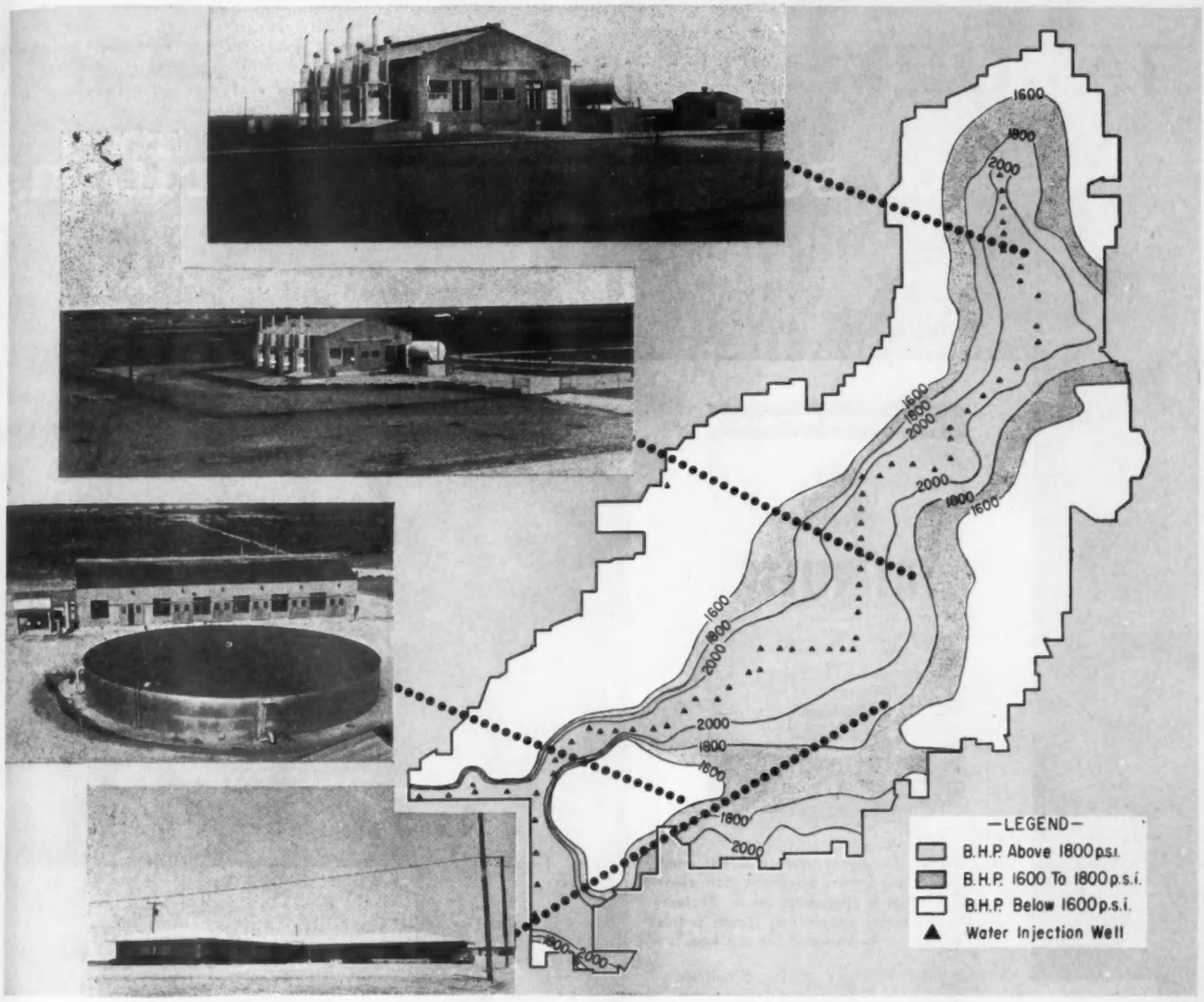

FIGURE 2—By January 1957, the pressure maintenance program at SACROC was well underway. Three pumping stations and the SACROC headquarters had utilized a row of injection wells to appreciably increase the bottom-hole pressure to the condition illustrated on the map. The positions of the pumping stations and unit headquarters are indicated on the map. Water injection wells presently in use give idea of the size of SACROC.

operated by Sun Oil Company. The efforts of these three Segments of SACROC Unit are coordinated and directed by the Scurry Area Canyon Reef Operators Committee, i.e., SACROC Unit. The enterprise includes 83 former operators, 320 working interest owners and approximately 2400 royalty owners who represent well over 99 percent of Kelly-Snyder field, Scurry County, Texas.

Not only the oil industry, but people generally are served to great advantage when the oil industry puts forth sufficient time, effort and money to almost double by pressure maintenance and secondary recovery the ultimate recovery from an extremely large field like Kelly-Snyder. First, it makes a vast amount of crude oil and its products available for public consumption which could not be produced except by unitization pressure maintenance. Second, immense tax payments on local, state and federal levels contribute to everyone's welfare.

Operations. The operation of SACROC is accomplished by smooth functioning Unit personnel applying good engineering and production methods to obtain good results as evidenced by production statistics and much improved reservoir conditions.

Bottom-Hole Pressure. It was estimated that over 2 billion barrels of oil would have remained in the reservoir after exhaustion of primary energy if the field had been allowed to produce under primary energy methods alone.

Early in 1950 the average bhp for the entire field was in excess of 1800 psi, but by July 1954, production had reduced these pressures to the point illustrated in Figure 1. Using a center-to-edge water injection plan to inject over 110,000,000 barrels of water, the bhp had been increased greatly by January, 1957, as shown by the bhp contours in Figure 2.

Re-establishment of reservoir pressures by water injection will permit recovery of about 51 percent of the oil originally in place. There is little question about the value of a conservation project that can increase ultimate recovery by some 700 million barrels.

Performance. Actually the problems and results obtained by SACROC

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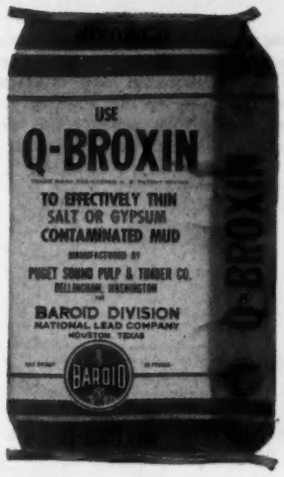

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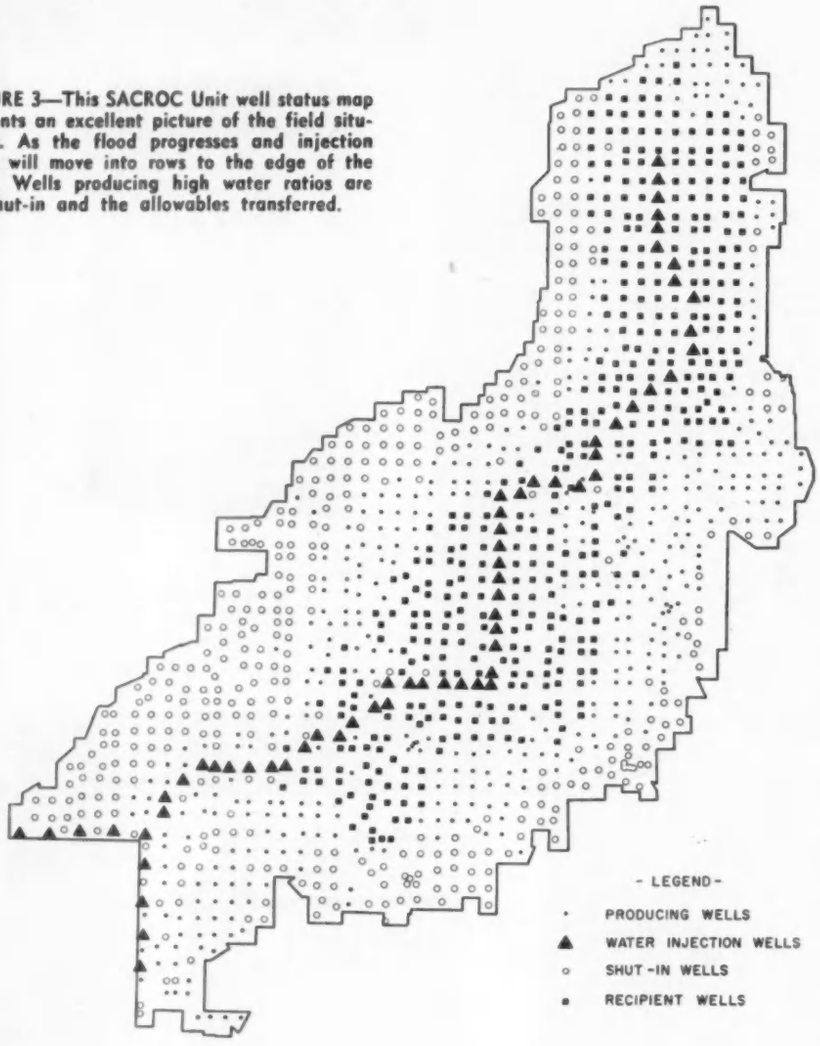

FIGURE 3—This SACROC Unit well status map presents an excellent picture of the field situation. As the flood progresses and injection wells will move into rows to the edge of the field. Wells producing high water ratios are shut-in and the allowables transferred.

read like a textbook example. Obviously, problems have been and continue to be encountered, but on the whole the operation is proceeding as planned. A glance at the performance chart, Figure 4, provides additional data on the progress of production and pressure maintenance at SACROC. Injection is still being carried on from a single row of wells in the center of the field. The less efficient edge wells are shut in and allowables transferred to the more efficient producing wells along the center of the field.

The position and number of injection wells in operation are illustrated by the SACROC Unit well status map in Figure 3. As of January, 1957, 435 wells, including 64 injection wells, were shut in with allowables transferred and there were 808 wells producing.

About the Manager

H. H. ALLEN had a multitude of experience behind him when he joined the SACROC Unit as manager in 1953. After graduating from The University of Texas with a degree in civil engineering, he was with the Texas State Highway department briefly. He then acquired experience with both cable tool and rotary rigs with The Pure Oil Company. He has been assistant chief engineer for Fish Constructors, Inc., Houston, general superintendent for Byrd-Frost of Dallas, chief engineer and managing vice president, Utah Natural Gas Company, Utah manager, Three States Natural Gas Company and manager and chief engineer of Featherlite Corporation.

Figure 5 shows cumulative injection and withdrawal since the SACROC operation started.

Water System. Pressure, for water injection, is provided from three high pressure pump stations. One station is located in each segment of the unit, with the low pressure station located in Segment 3 supplying all three high-pressure stations. A schematic diagram in Figure 6 illustrates this system. Lake J. B. Thomas, the source of fresh water, has afforded an ample supply. Produced water will increase with time. Preparations already have been made, and currently, produced water is being injected. This preparedness is typical of the approach which SACROC takes to foreseeable problems and this does much to reduce their magnitude.

Water Treatment. During the initial operation, the water was treated for injection by using lime to adjust the pH, alum for coagulation, septiphosphate as a stabilizing agent and chlorine as a bactericide. After treating the water and observing results for about a year, some changes were made in the treatment because of evidences of corrosion. Alum was replaced by ferric sulphate and the pH was adjusted to 9.3 instead of 8.4. The water was not scale forming and septiphosphate was found unnecessary, so its use was discontinued. Although chlorine is not effective as a bactericide at this pH, it has been continued as an algaecide. On three separate occasions, an organic bactericide has been used for five days as a slug treatment. It was necessitated by the appearance of sulfate reducing bacteria which were successfully destroyed.

Corrosion. Most water-flood projects experience corrosion to one degree or another and SACROC is no exception. They do, however, make it a practice to keep a close check on the intensity of any corrosion in their system.

A short time ago, a considerable amount of corrosion products was noticed in some of the injection wells. Corrosion coupons and spools indicated that corrosion existed in the system. The possibility of future expensive workover programs resulting from corrosion justified the cost of remedial action.

After field research and studying

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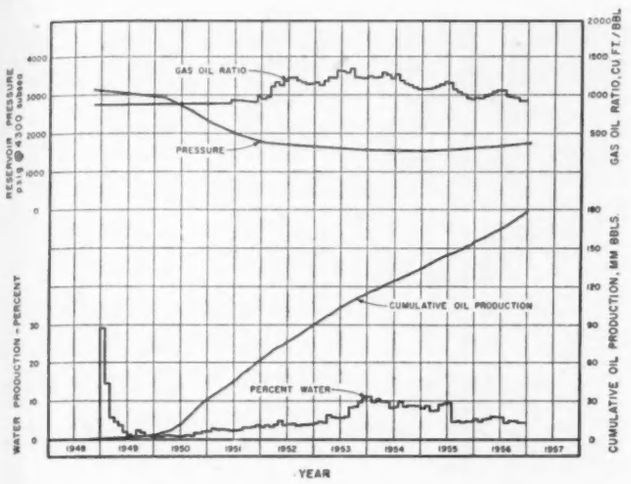

GAS OIL RATIO
PRESSURE
CUMULATIVE OIL PRODUCTION
PERCENT WATER
RESERVOIR PRESSURE p.s.i.g. @ 4300 subsea
WATER PRODUCTION - PERCENT
GAS OIL RATIO, CU FT./BBL.
CUMULATIVE OIL PRODUCTION, MM BBLS.
1948 1949 1950 1951 1952 1953 1954 1955 1956 1957
YEAR

FIGURE 4—The Kelly-Snyder performance chart reflects the influence of the pressure maintenance project. The SACROC operation should be a successful one.

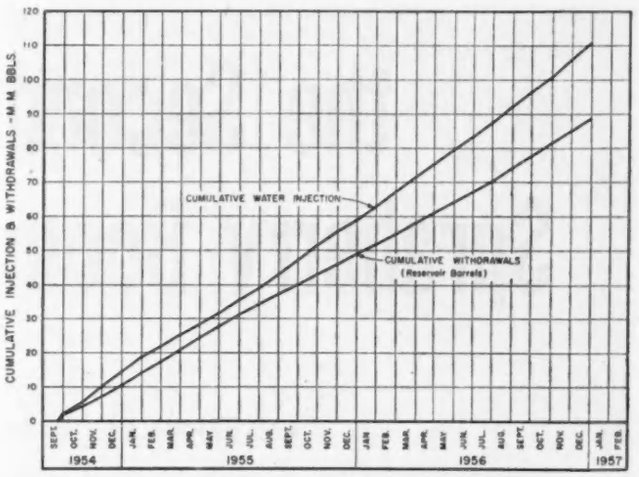

CUMULATIVE WATER INJECTION
CUMULATIVE WITHDRAWALS (Reservoir Barrels)
CUMULATIVE INJECTION & WITHDRAWALS - M M BBLS
SEPT OCT NOV DEC
1954
JAN FEB MAR APR MAY JUN JUL AUG SEPT OCT NOV DEC
1955
JAN FEB MAR APR MAY JUN JUL AUG SEPT OCT NOV DEC
1956
JAN FEB
1957

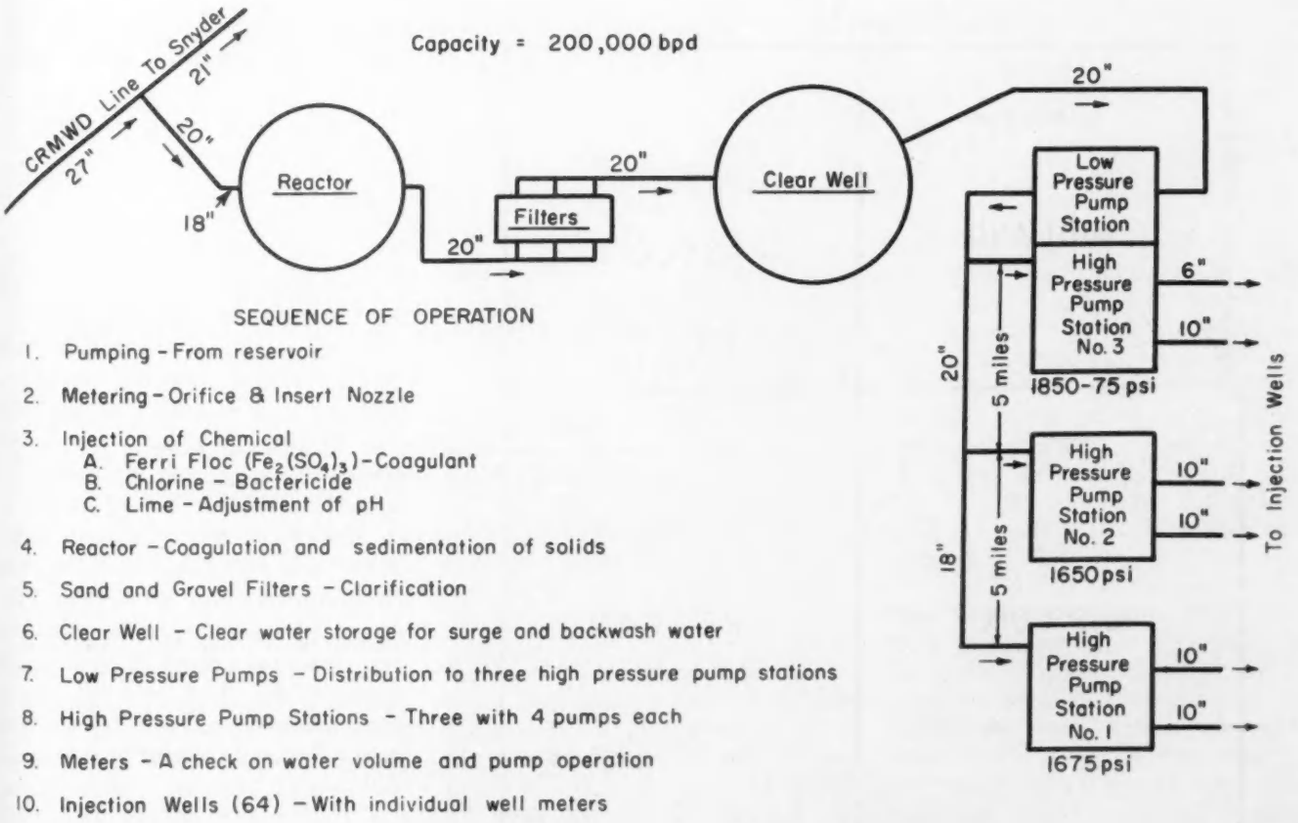
FIGURE 5—The size and constance of this pressure maintenance operation is indicated to a degree by the SACROC Unit injection and withdrawal chart.

the economic possibilities of chemical treatment, vacuum deaeration and desorption of oxygen by natural gas counter current stripping, it was decided to use the latter.

A pilot plant handling approximately 2000 barrels of water per day was operated for over a year. The effluent was used to operate the hydraulic valves in the filter plant. On the basis of the data obtained, a full scale plant is now being installed. It is expected that the oxygen content of the water will be reduced from 10 ppm to 0.2 ppm.

Conclusion. This is just one example of the breadth of the SACROC operation. Their ability to run tests, construct models and design equipment in addition to carrying on daily activity is one reason for the phenomenal success of the project. The cooperation of the parties involved, plus initiative and experienced leadership, not only keep them abreast of their problems but ahead of them. The petroleum industry can look with pride at a conservation operation that will add considerably to the wealth of the nation and provide a pattern for future projects of a similar scope.

—The End



SEQUENCE OF OPERATION

1. Pumping - From reservoir
2. Metering - Orifice & Insert Nozzle
3. Injection of Chemical
   A. Ferri Floc ($Fe_2(SO_4)_3$) - Coagulant
   B. Chlorine - Bactericide
   C. Lime - Adjustment of pH
4. Reactor - Coagulation and sedimentation of solids
5. Sand and Gravel Filters - Clarification
6. Clear Well - Clear water storage for surge and backwash water
7. Low Pressure Pumps - Distribution to three high pressure pump stations
8. High Pressure Pump Stations - Three with 4 pumps each
9. Meters - A check on water volume and pump operation
10. Injection Wells (64) - With individual well meters

FIGURE 6—The water treating and injection in use at SACROC is shown schematically above. An additional system is under construction to handle the quantities of produced water expected with continued operations.

the Second Spraberry Boom

Development of the Spraberry is another of West Texas' material contributions to the petroleum industry

By LEROY GIDEON, Production Superintendent
Rowan Oil Company
Fort Worth

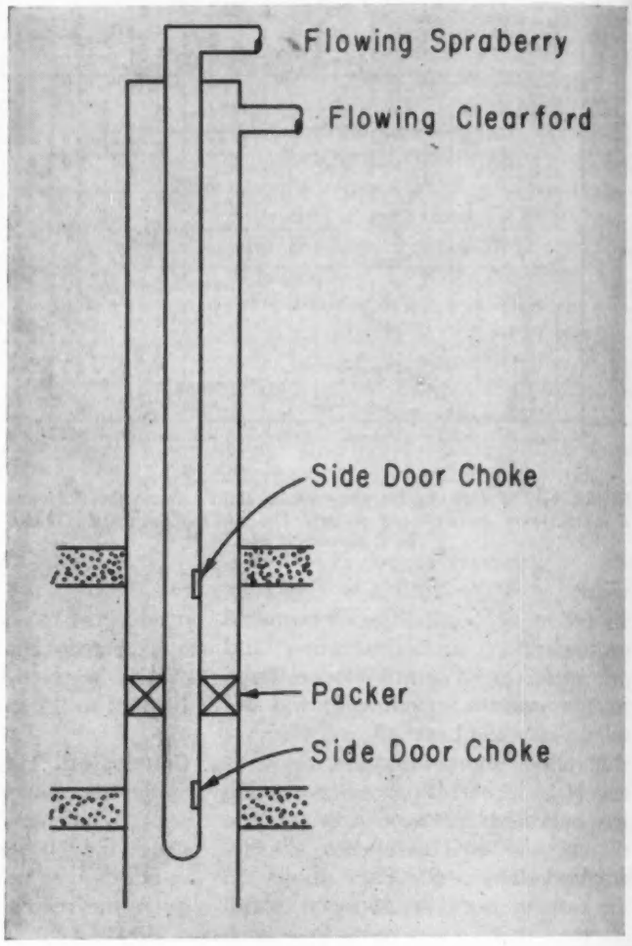
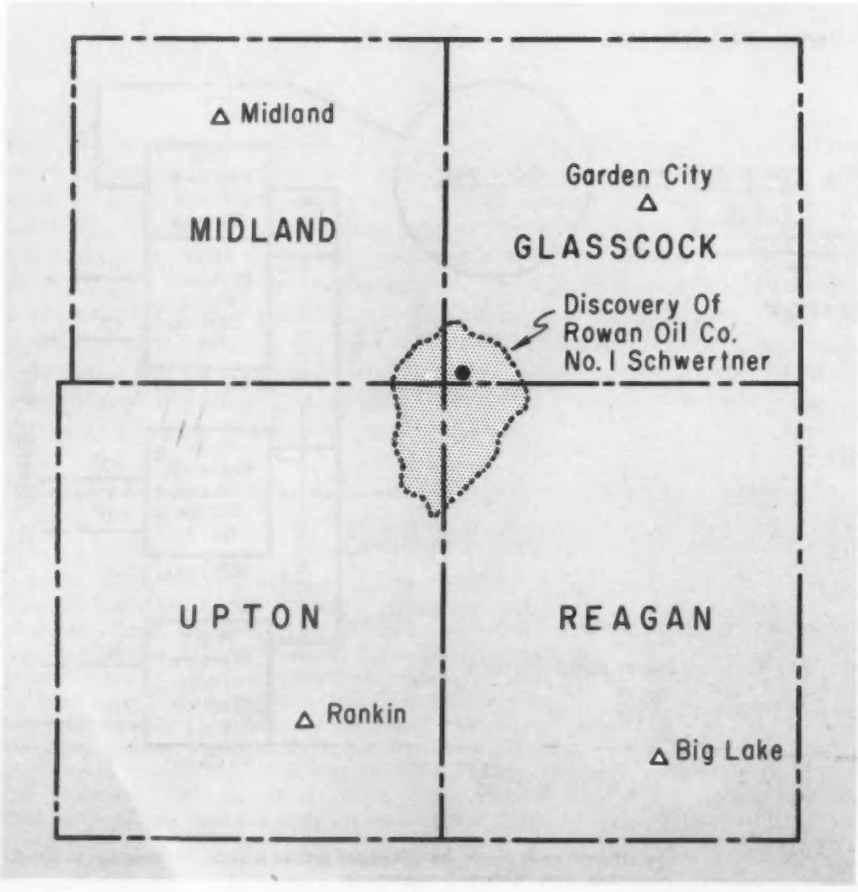


FIGURE 1—This is the most common dual completion method used to produce the Clear Fork and Spraberry in 5½-inch casing.



Shown at left is Rowan Company's Schwertner 1 in the general area of the Spraberry Clear Fork.

THE SPRABERRY Clear Fork has been a salvation to many operators who were victims of financial losses in the development of the Spraberry field. It is estimated conservatively that 75 percent of all leases in the Spraberry were in the red when the first Clear Fork well was completed in May, 1955. Since the completion of the first Clear Fork well, Rowan Oil Company Frank Schwertner 1 the second Spraberry boom got under way and operators gained a renewed interest in what had been one of the most disappointing oil fields in West Texas. Through August 31, 1956, 325

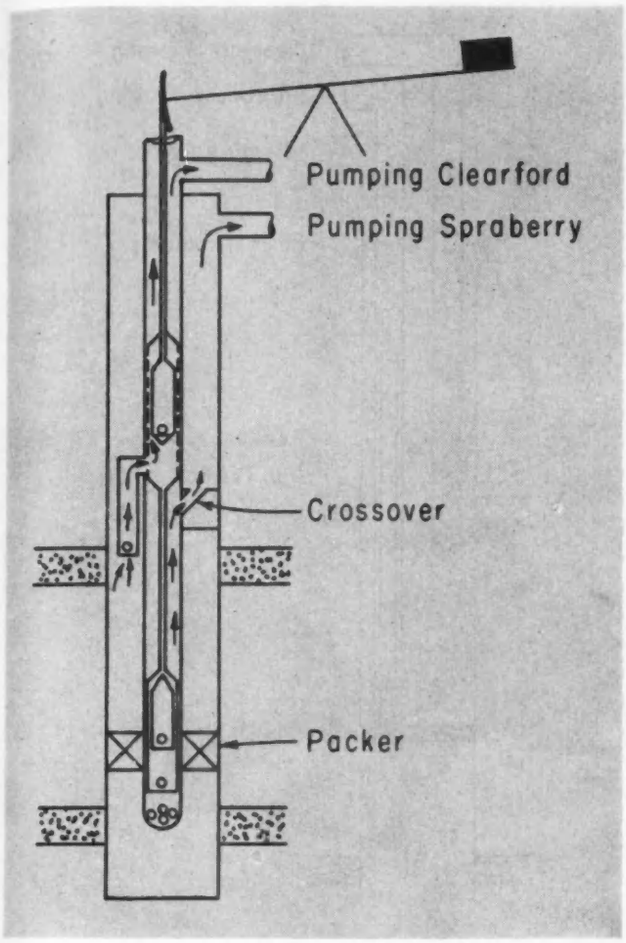


FIGURE 2—Another completion method in 5½-inch casing uses a two-zone pump. With a packer between the 2 zones, 2 pumps work on one string of rods. This method is not widely used at the present time.

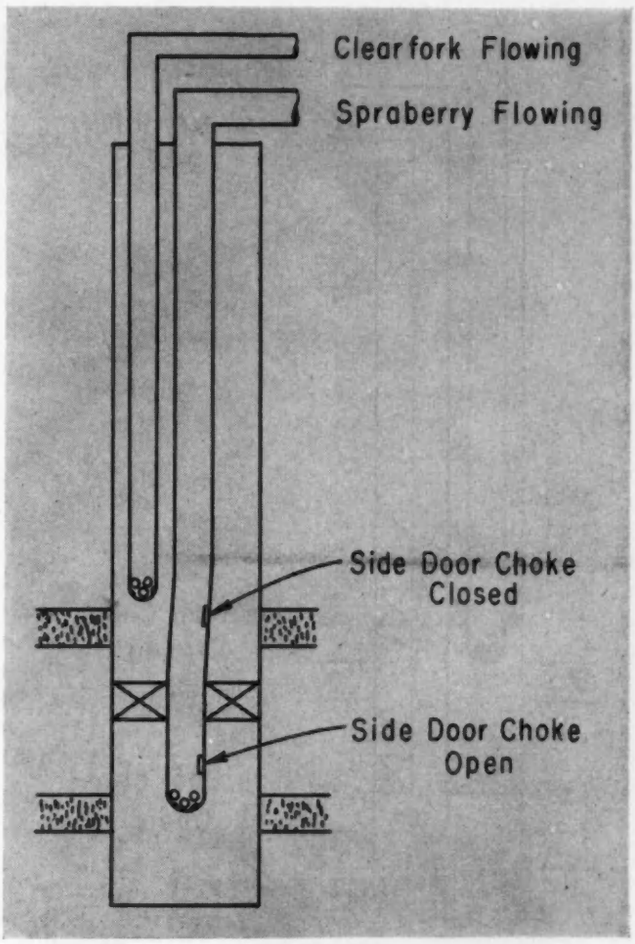


FIGURE 3—This is a very common completion procedure where 7-inch casing has been run. 2-inch tubing is run to the lower zone and 1¼-inch or 2⅜-inch tubing is run to the Clear Fork zone.

wells had been completed from the Clear Fork and had recovered approximately 3,600,000 barrels of oil.

The Spraberry Clear Fork, often referred to as Schwertner Clear Fork, is approximately 500 feet above the Spraberry, and consists of one main dolomitic lime stringer varying in thickness from 5 to 35 feet. Accompanying this Schwertner stringer, in some areas, are two other Clear Fork stringers that have proven productive.

Reservoir. The Clear Fork, like the Spraberry, does not depend on structural closure for production. Productive ability is a result of permeability and porosity which is very inconsistent in vast areas in Midland, Upton, Reagan and Glasscock counties.

It would be difficult to estimate accurately the average porosity and permeability of the Spraberry Clear Fork. The most productive Clear Fork stringer, sometimes referred to as Zone No. 1 (Schwertner Clear Fork), has porosity as high as 30 percent and permeability up to 500 milidarcys. In some areas this same stringer will have both porosity and permeability as low as zero. The average porosity and permeability throughout the productive Clear Fork area is approximately 12 percent and 75 milidarcys respectively.

Initial Test. Attention was first turned to the Schwertner Clear Fork in July, 1951, when a drillstem test from 6305-6410 feet was run in Rowan Oil Company's Frank Schwertner.[1] This test recovered 4200 feet of free oil in two hours with no water. Cores from Rowan's F. A. Braden 1 prompted testing in the Schwertner well. The same interval in Rowan's Schwertner 2 was tested 7 hours with oil to the surface after the tool had been open 4 hours and 45 minutes. Seven and one-half barrels of oil flowed to the surface during the last 2 hours and 15 minutes of the test. The flowing pressure was 740 pounds per square inch with a 30-minute shut-in bottom hole pressure of 2170 psi.

2nd Spraberry Boom. As development of the Spraberry progressed, the Clear Fork was cored and tested in several other wells. However, approximately four years elapsed before the first Clear Fork completion was attempted Rowan's Schwertner 1, the first Clear Fork completion, triggered the second Spraberry boom. In May, 1955, the Schwertner 1 was perforated

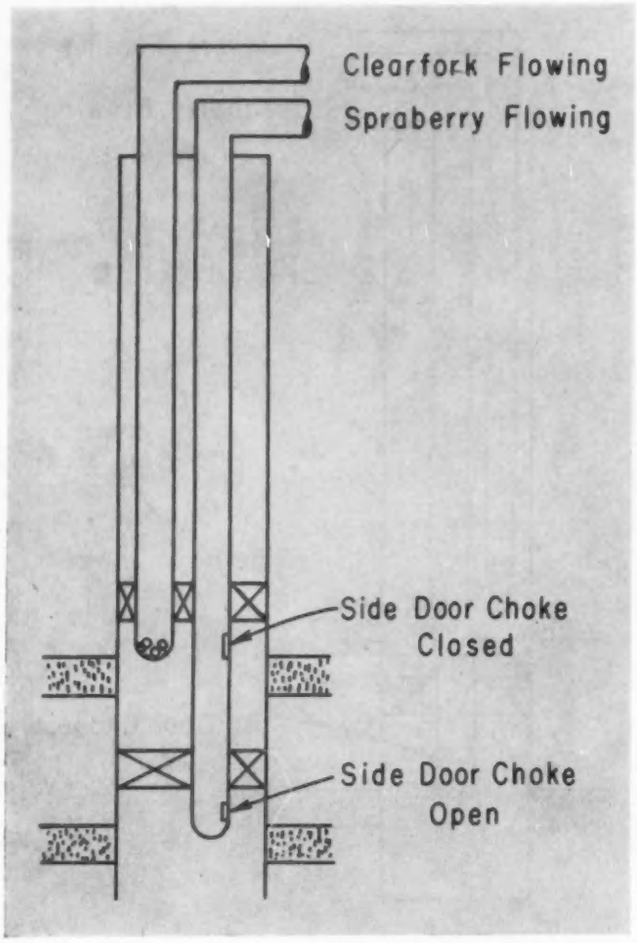


FIGURE 4—Here, two strings of tubing are shown with two packers, one set above the Clear Fork, the other below. This type of completion costs about $10,000 and as a result is not in common use in the area.

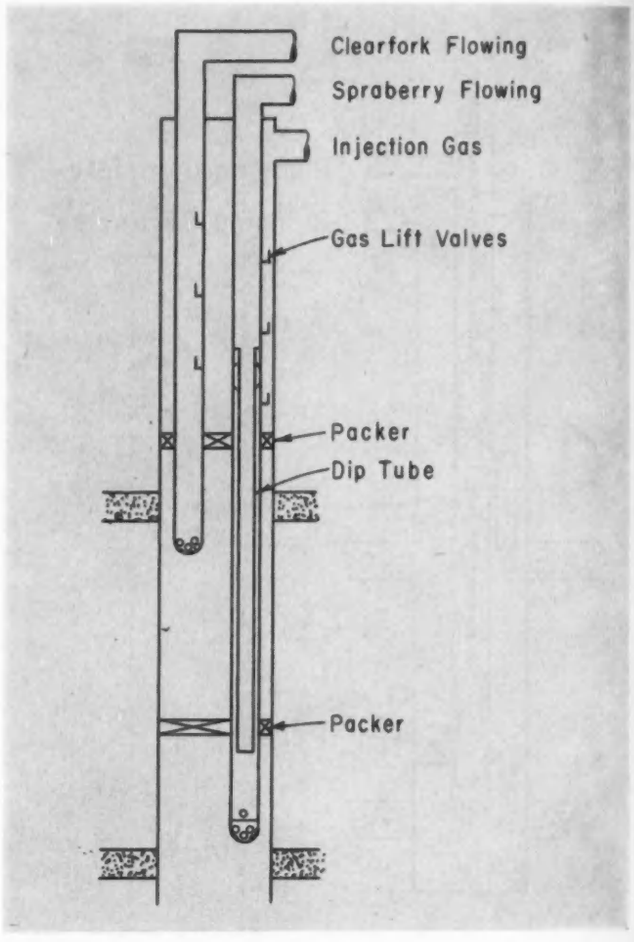


FIGURE 5—This method utilizes 2 strings of tubing, 2 packers, 2 strings of gas lift valves and a dip tube. Here again the cost of the installation prohibits its use in areas where reserves are limited.

from 6393 feet to 6401 feet with four shots per foot. After acidizing with 500 gallons of mud acid down the tubing, the swab was pulled four times and the well kicked off. This well potentialed for 484 barrels of 36.1° gravity oil per day through ½-inch choke with a tubing pressure of 100 psi. The gas-oil ratio was 875-1.

Production History. Production history on the Schwertner Clear Fork is generally following that of the Spraberry, that is, flush production, decrease in bottom hole pressure and increase in gas-oil ratio. Initial bottom hole pressure averaged 2025 psi on the early completions with gas-oil ratios ranging from 800 to 1000. Some wells potentialed for as much as 1100 barrels oil per day. After an average of 9000 barrels per well had been produced, bottom hole pressures had decreased to 1000-1400 psi and the gas-oil ratio climbed to as high as 30,000 to 1. However, the average ratio was below 15,000 to 1 after a recovery of 9000 barrels of oil per well. Latest reports show a large percent of the early completions currently producing less than 10 barrels of oil per day with ratios of 50,000-1 and bottom hole pressures as low as 650 psi.

Outlined in Table 1 are production figures for five months in 1956. This data is taken from District 7-C only but is representative of the typical decline experienced by Spraberry Clear Fork wells. At the present time it is estimated the average GOR would be 20,000-1.

TABLE 1

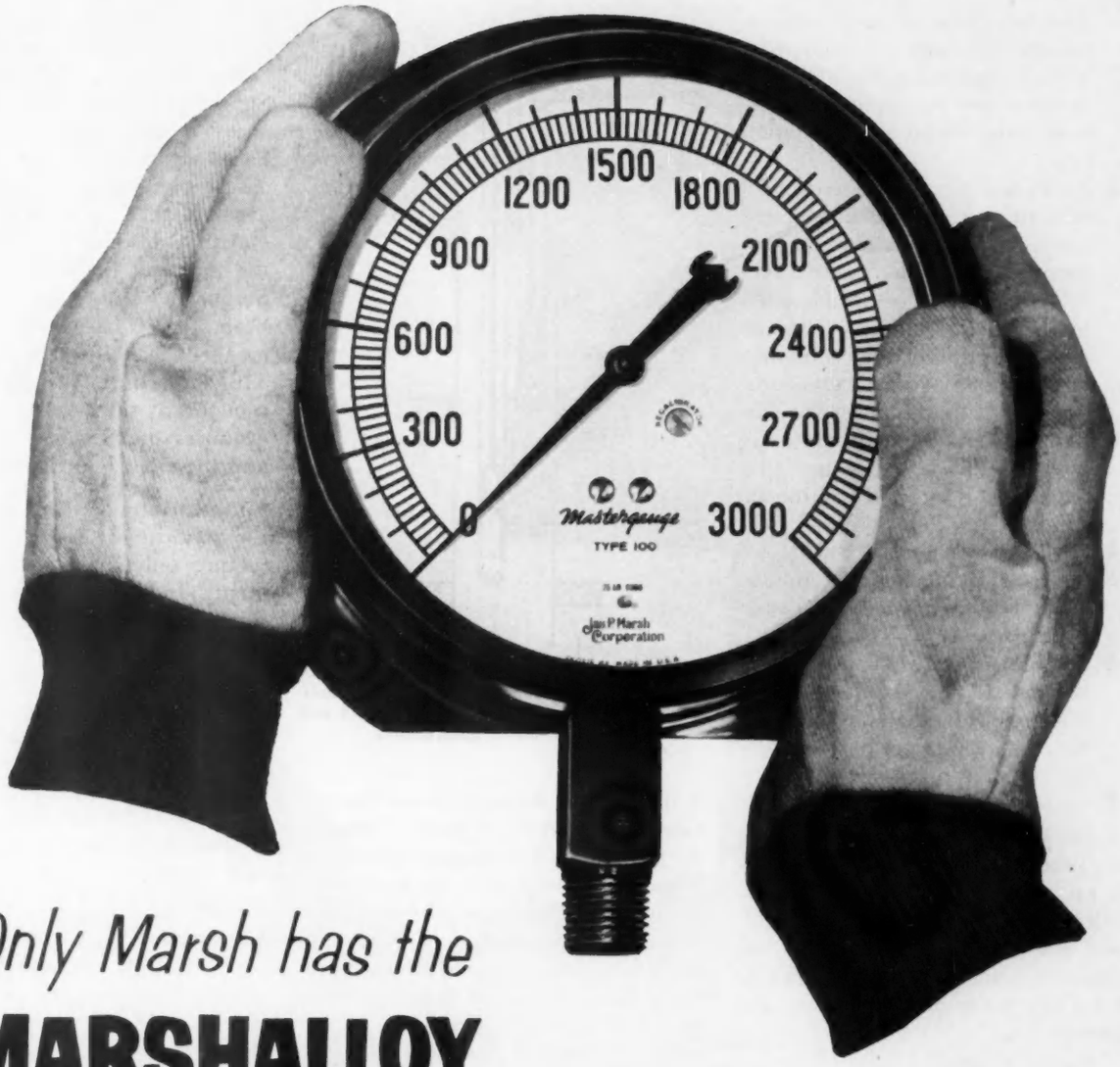
	No. of Wells	Barrels Produced-Oil	Gas Produced-MCF	GOR
May	196	383,987	1,557,234	4,000
June	222	361,637	1,902,088	5,300
July	233	337,063	2,193,408	6,500
August	241	277,723	2,277,875	8,200
September	245	229,736	2,311,937	10,000

Through August, 1955, the Railroad Comission reported 18 completions had been filed; 54 through October; 157 through January, 1956, and the above data for a five-month period reflects the rapid development through August. It was in January the Railroad Commission issued field rules for the Spraberry Trend area Clear Fork field.

Field Rules. The Commission adopted the following rules to govern the drilling and production from the Clear Fork zone.

1. 660 feet—1200 feet spacing.

2. Proration unit rule which pro-



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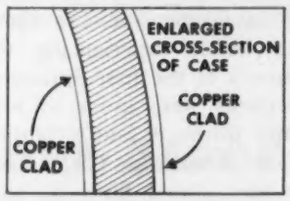

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vides for 80-acre units plus an 80-acre tolerance for each well; with a maximum of 3000 feet between the two points farthermost removed on each proration unit.

3. Allocation formula based on 75 percent acreage plus 25 percent per well with the additional provision that wells previously drilled, drilling, or recompleted to the Clear Fork on a 40-acre unit as established by Commission regulations that cannot under any circumstances be assigned a full 80-acre unit will have an allowable assigned that is equal to that of a well on 80 acres.
4. 2000-1 GOR limit.
5. Granted permission to comingle Clear Fork and Spraberry casing head gas.
6. Established the MER at 121 barrels per well per day for wells on 80-acre proration units and 212 barrels per well per day for wells on 160 acre proration units.
7. Flare gas prohibited.

Completions on 80-acre spacing have produced an average 16,000 barrels per well, or 200 barrels per acre. Predictions on total recovery vary from 300-350 barrels per acre. As previously pointed out, well performance is dependent on permeability and porosity.

Completions. Completion procedures have been as fantastic as the Spraberry itself. After experiencing the disappointment of the first Spraberry boom, operators were quick to seek out economic workover and recompletion methods when the Clear Fork boom was inaugurated. Since the majority of the original Spraberry wells were still producing, dual completions became common practice.

The most common dual method, particularly in 5½-inch casing, was to complete with the Spraberry producing through tubing and the Clear Fork producing through the tubing-casing annulus. This was usually accomplished by pulling tubing, perforating Clear Fork, rerunning tubing, packer, and sidedoor chokes as shown in Figure 1. By running tubing in with the top choke open and bottom choke closed, Clear Fork was acidized, swabbed in, chokes changed, and both zones on production in less than three days and for an average cost of $3500.

Another completion method, Figure 2, in 5½-inch casing, utilized the two zone pump. With a packer between the two zones, two pumps operate on one string of rods with the lower zone kicking over into the annulus by a crossover. This method of dual completion is not common in the Spraberry Clear Fork, but is in operation on three or more wells.

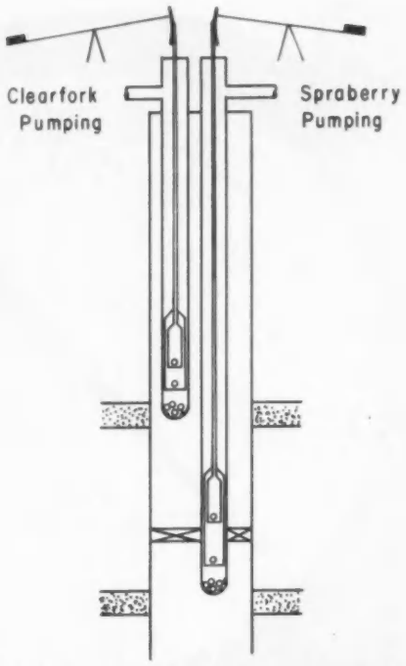


FIGURE 6—Here is a fairly common practice in the Spraberry Trend area for handling duals. It is an extremely expensive method and payout is often questionable.

Figure 3 shows a very common completion procedure where 7-inch casing has been run. Two inch tubing is run to the lower zone with packer set between the two zones, and with sidedoor chokes above and below the packer. The second string of tubing, 1¼-inch or 2⅜-inch, is run to the Clear Fork zone. Completion is effected as in Figure 1.

Two strings of tubing are shown in Figure 4 with two packers, one set above the Clear Fork, the other below. This type of completion, costing an average of $10,000, is naturally more expensive than that shown in Figure 3, and is not common practice in this area.

Figure 5 reflects ingenuity and a practical completion method in certain areas. Two strings of tubing, two packers, two sets of gas lift valves and a dip tube are used in this method of completion. This operation is expensive and due to limited reserves, it is not favored for duals in the Spraberry Clear Fork. However, it has its place in the oil field and will no doubt be utilized in fields with sufficient reserves to justify its application.

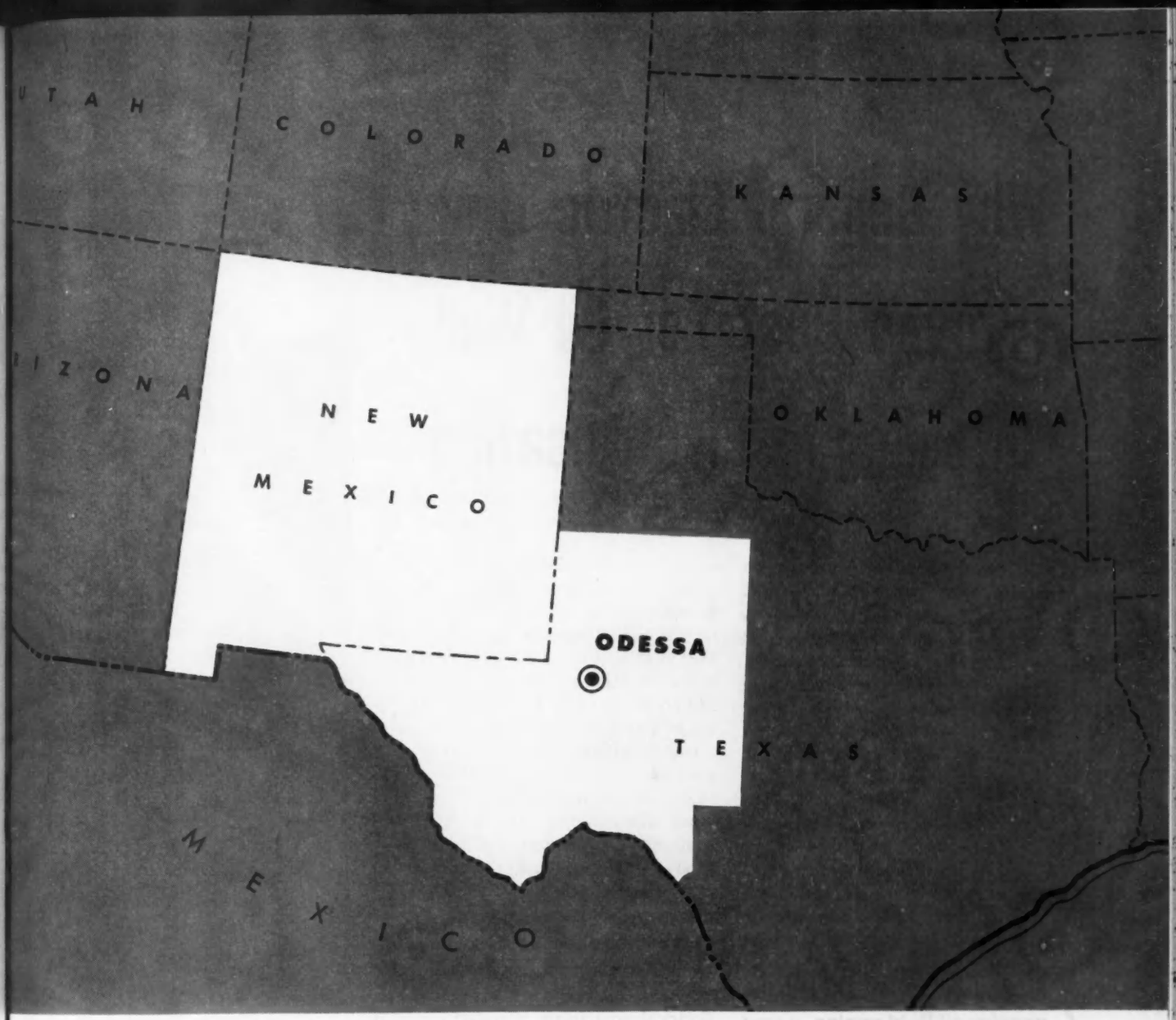
Figure 6 is fairly common in the Spraberry Trend area, especially in areas where both zones have low permeability. This type completion is also expensive and payout status in each instance is doubtful.

Although dual completions are in the majority in the Clear Fork and Spraberry wells, over 130 wells had been plugged back from the Spraberry to the Clear Fork in August, 1956. This procedure was naturally more economical than duals, and in many instances the Spraberry was depleted and the wells temporarily abandoned.

Stimulation. Unlike the Spraberry, the majority of Clear Fork completions require only low volume acid treatments. In several isolated areas, particularly in the four corners area (Midland, Glasscock, Upton, Reagan adjoining corners), excellent production resulted from 500 gallons of mud acid. In other areas of low permeability and porosity large volume frac treatments were utilized without success. Also unlike the Spraberry, second treatments to the Clear Fork, regardless of type or size, have not been successful.

Revenue. If each Clear Fork completion produces an average of only 10,000 barrels of oil per well (this figure is currently less than average), the operators will have realized a substantial income that will change their over-all Spraberry payout status from red to black. The average cost of Clear Fork completions has been approximately $6500, based on all type completions in the Clear Fork. Average net revenue indicates a $17,000 (excluding casing head gas revenue) profit from Clear Fork completions. In many cases, this figure will represent the break-even point for some operators in the Spraberry, and for others it represents profit.

Include the Clear Fork production and it is obvious what a salvation it has been and will further be to Spraberry operators. Net profits, of course, will be dependent on type of completions and well performance. Income from Clear Fork wells has averaged 12 percent of total income per well. That is, of total revenue from Spraberry and Clear Fork, the Clear Fork has contributed 12 percent. And the expense to gain this revenue has been only 5 percent of the total development cost. —**The End**



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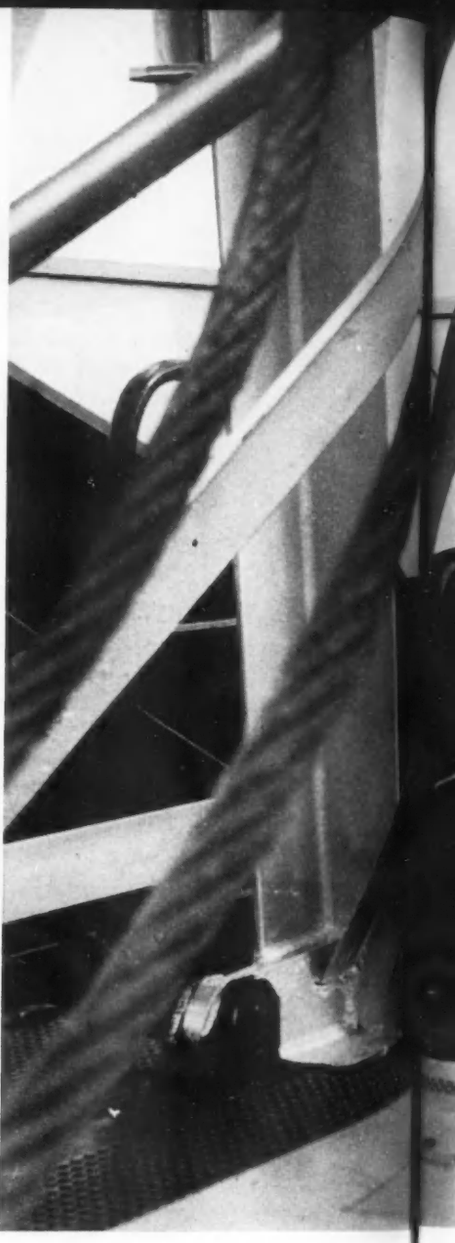

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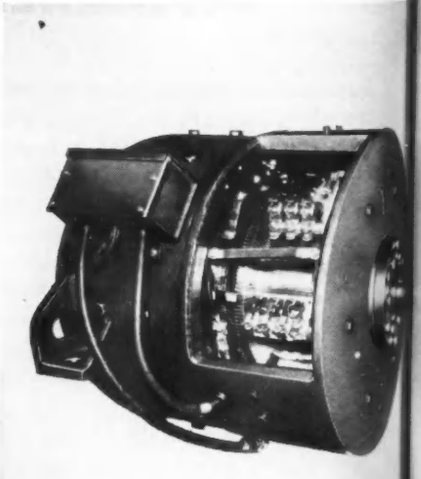

GT558R1 direct current main generator with inspection covers removed.

Operator at drilling controls of General Electric equipped rig built for Shell Oil Company by Ideco, one of the Dresser Industries. Standard air throttles are used for speed controls. These can be incorporated in the draw works console with other air controls, simplifying operation.

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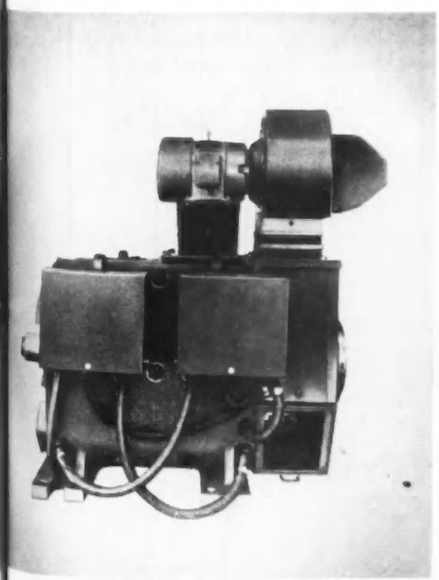
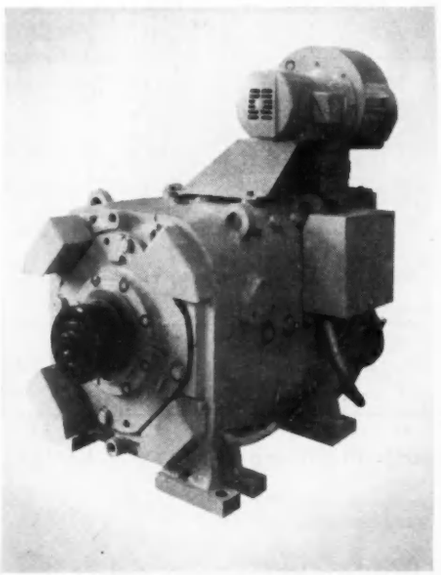
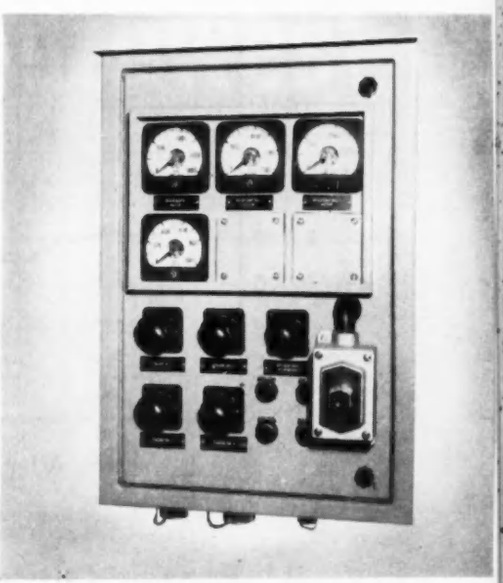


GE752J direct current main generator with top-mounted blower assembly.



GE752H2 direct current, 1000 hp motor with top-mounted blower assembly.



General Electric control console for use at driller's position.

Spraberry Refracturing Proves Successful

Case histories on 16 wells indicate that large-volume, high-velocity fracture treatments in the Spraberry get results.

By STEVEN GEROLDE, Petroleum Engineer
Producers Development Company
Fort Worth

ALTHOUGH LARGE-VOLUME, high-velocity hydraulic fracture treatments were generally classified as only fair in the Spraberry Trend area of West Texas, one company has reported remarkable success with this workover technique.

Sixteen wells were fractured and the treatments were 100 percent successful. In some cases secondary potential tests were larger than original completion potentials.

Success of the fracture treatments is credited entirely to the large-volume, high-velocity procedure. This conclusion is reached because at original completion the wells generally were fractured with about 4500 gallons of an oil-base medium carrying about 2400 pounds of 20-40 mesh sand without remarkable results. The treatments were performed through 2⅜-inch OD EUE tubing at an average injection rate of about 5 barrels per minute. Under these conditions it is obvious that high treating pressures were required, in the magnitude of 2000 to 4000 pounds per square inch.

Secondary fracture treatments were performed down 5½-inch OD casing

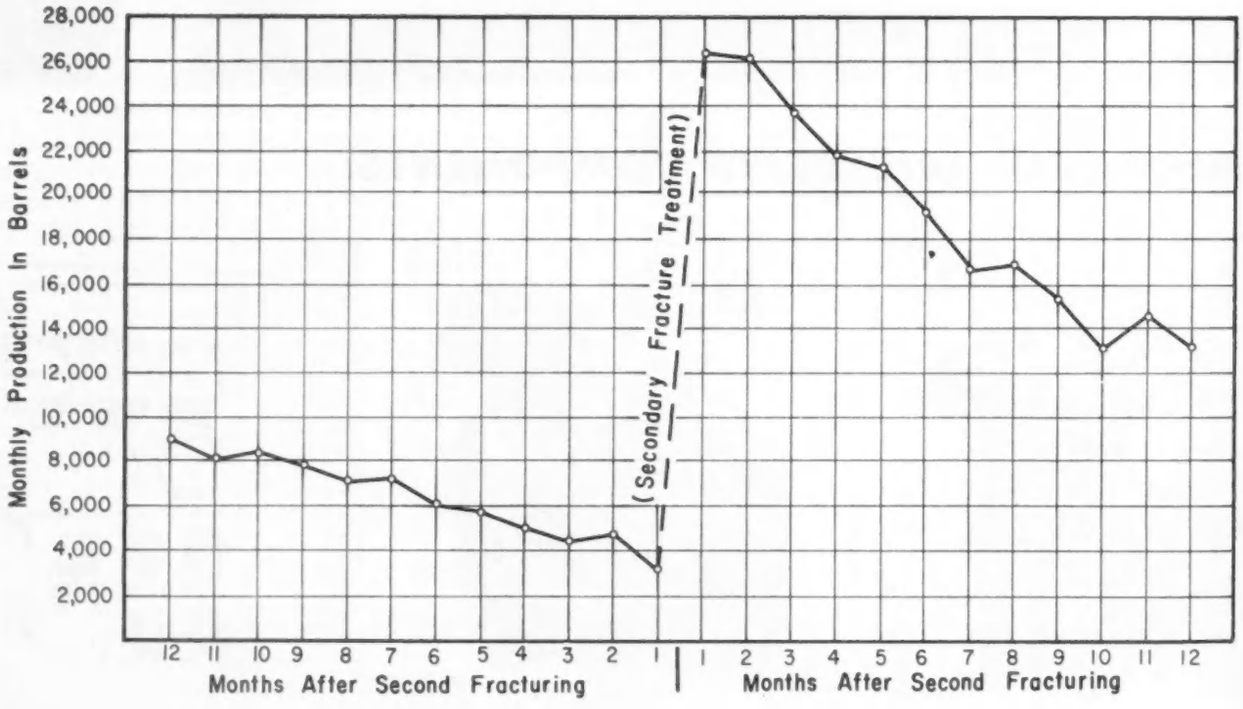


FIGURE 1—This is a graphic illustration of the average monthly production of the 16 wells for 12 months before and after the large-volume, high-velocity fracture treatment. The success of this workover technique is evident.

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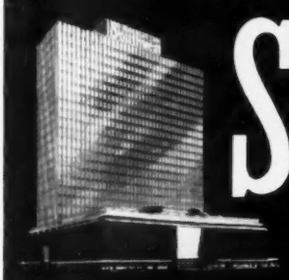

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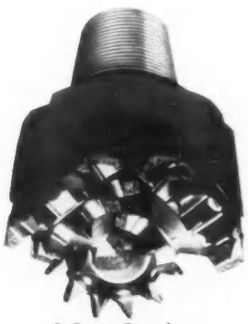

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with the tubing pulled. About 21,000 gallons of an oil-base medium were used to carry nearly 31,500 pounds of 20-40 mesh sand. The pressures were much lower (due to negligible friction) being between 1000 and 1500 psi, depending on permeability. Using this type of treatment, injection rates of 50 barrels per minute were very common.

The amount of flush fluid did not appear to be a critical item. Varying gallonages were used, ranging from a volume equal to that of the oil-base, fracturing fluid to twice the volume of the oil-base fluid. It was generally agreed, however, that the volume of the flush fluid should at least equal the volume of injected fracture fluid.

Wells were left closed-in for 24 hours after treatment and in only a few cases was any difficulty experienced in swabbing them in. Some wells, classified as flowing before the

TABLE 1—Detailed Pertinent Data on Original and Secondary Completion Treatments

Well Number	ORIGINAL COMPLETION FRACTURE TREATMENT								
	Original Completion Date	Initial Potential in BOPD	Gallons of Fracturing Fluid	Pounds of Sand	Treating Pressures		Gallons of Flush Fluid	Injection Rate in Barrels per Minute	
					Minimum	Maximum		Frac. Fluid	Flush Fluid
1	12–18–51	560-F	4500-T	4800	1700	2300	9,870	5.42	5.42
2	2– 2–52	525-F	4500-T	2400	2700	3400	9,954	5.50	5.50
3	3– 9–52	485-F	4500-T	2400	3200	3400	9,828	5.74	5.74
4	4–14–52	265-F	4500-T	2400	2200	3300	3,360	6.00	6.00
5	4–21–52	609-F	4500-T	2300	1900	3000	5,376	5.24	5.24
6	6– 5–52	67-P	9000-T	4600	2050	2500	11,424	4.95	4.95
7	5–19–52	405-F	4500-T	2400	2400	3500	3,276	7.24	7.24
8	7– 7–52	252-F	4500-T	2400	1500	2700	3,780	5.36	5.36
9	6–27–52	159-F	4500-T	2300	2500	2700	5,712	4.69	4.69
10	9– 9–52	320-F	4500-T	2300	1700	3000	3,360	5.55	5.55
11	10–16–52	84-P	4500-T	2300	2000	3500	3,780	7.43	7.43
12	5–25–52	375-F	4500-T	2300	2000	3000	3,276	5.40	5.40
13	7–11–52	225-F	4500-T	2300	1800	2500	5,670	6.24	6.24
14	1–21–52	20-P	9000-T	4800	1850	3200	23,400	4.02	4.02
15	10–15–53	102-P	6000-T	3000	2600	4050	3,192	4.38	4.38
16	2–17–51	98-F	3000-T	1600	2225	4600	2,394	3.76	3.76

T—thru tubing. C—thru casing. P—pumping. F—flowing.

Well Number	SECONDARY COMPLETION FRACTURE TREATMENT							
	Date of Treatment	Gallons of Fracturing Fluid	Pounds of Sand	Treating Pressures		Gallons of Flush Fluid	Injection Rate in Barrels per Minute	
				Minimum	Maximum		Frac. Fluid	Flush Fluid
1	10–13–54	42,000-C	63,000	1300	1700	51,660	50.5	53.0
2	2–22–55	21,000-C	31,500	1050	1350	29,400	50.2	50.0
3	1–20–55	21,000-C	31,500	1200	1500	31,920	50.0	44.7
4	6–22–54	21,000-C	31,500	1250	1275	29,652	50.4	44.8
5	11–21–54	21,000-C	31,500	1400	1400	28,980	55.9	59.5
6	5–20–54	21,000-C	31,500	1200	1450	39,900	41.7	44.1
7	1– 6–55	21,000-C	31,500	1300	1500	32,844	53.5	46.0
8	2– 8–55	21,000-C	31,500	1300	1500	32,340	53.3	47.6
9	10–24–54	21,000-C	31,500	1400	1650	35,490	49.7	46.4
10	1–13–55	21,000-C	31,500	1500	1500	53,004	44.5	50.4
11	2–12–54	21,000-C	31,500	450	1150	25,116	42.0	42.7
12	10–14–54	21,000-C	31,500	1000	1100	50,484	45.8	49.2
13	7– 2–54	21,000-C	31,500	1050	1200	29,316	50.0	43.6
14	6–11–54	21,000-C	31,500	1100	1450	22,554	41.7	38.1
15	11–10–54	21,000-C	31,500	1200	1800	30,240	37.5	43.6
16	3–11–55	20,000-C	30,000	1600	2000	37,800	42.0	41.0

T—thru tubing. C—thru casing. P—pumping. F—flowing.

Well Number	Test Prior to Secondary Fracture Treatment In BOPD	Secondary Potential In BOPD	Number of Months From Original Completion To Date of Secondary Fracture Trearment	Cumulative Production Prior to Secondary Fracture Treatment (In Barrels)	Number of Months From Secondary Fracture Treatment To 8–1–56	Cumulative Production From Date of Secondary Fracture Treatment To 8–1–56 (In Barrels)	Current Production (July–1956) In BOPD
1	8-F	159-F	34	37,986	22	27,985	33-F
2	3-F	124-P	37	46,835	17	19,391	14-P
3	1-F	333-F	34	55,438	18	34,155	25-F
4	17-P	532-F	26	24,934	25	38,852	13-F
5	18-F	214-F	31	48,965	20	26,354	20-F
6	5-P	352-F	23	7,528	26	51,990	23-F
7	28-F	143-P	31	53,841	19	32,012	18-P
8	3-F	121-P	31	32,493	18	22,760	33-F
9	15-F	525-F	28	30,317	21	54,682	31-F
10	15-F	506-P	28	37,126	19	52,474	67-P
11	2-P	424-F	15	5,276	30	42,706	20-F
12	12-F	389-F	28	36,884	22	26,416	9-F
13	7-F	336-F	24	21,166	25	21,776	10-F
14	14-P	57-P	29	11,389	26	23,319	26-P
15	32-P	81-P	13	14,649	21	29,828	37-P
16	41-P	80-P	49	61,259	17	19,464	37-P

T—thru tubing. C—thru casing. P—pumping. F—flowing.

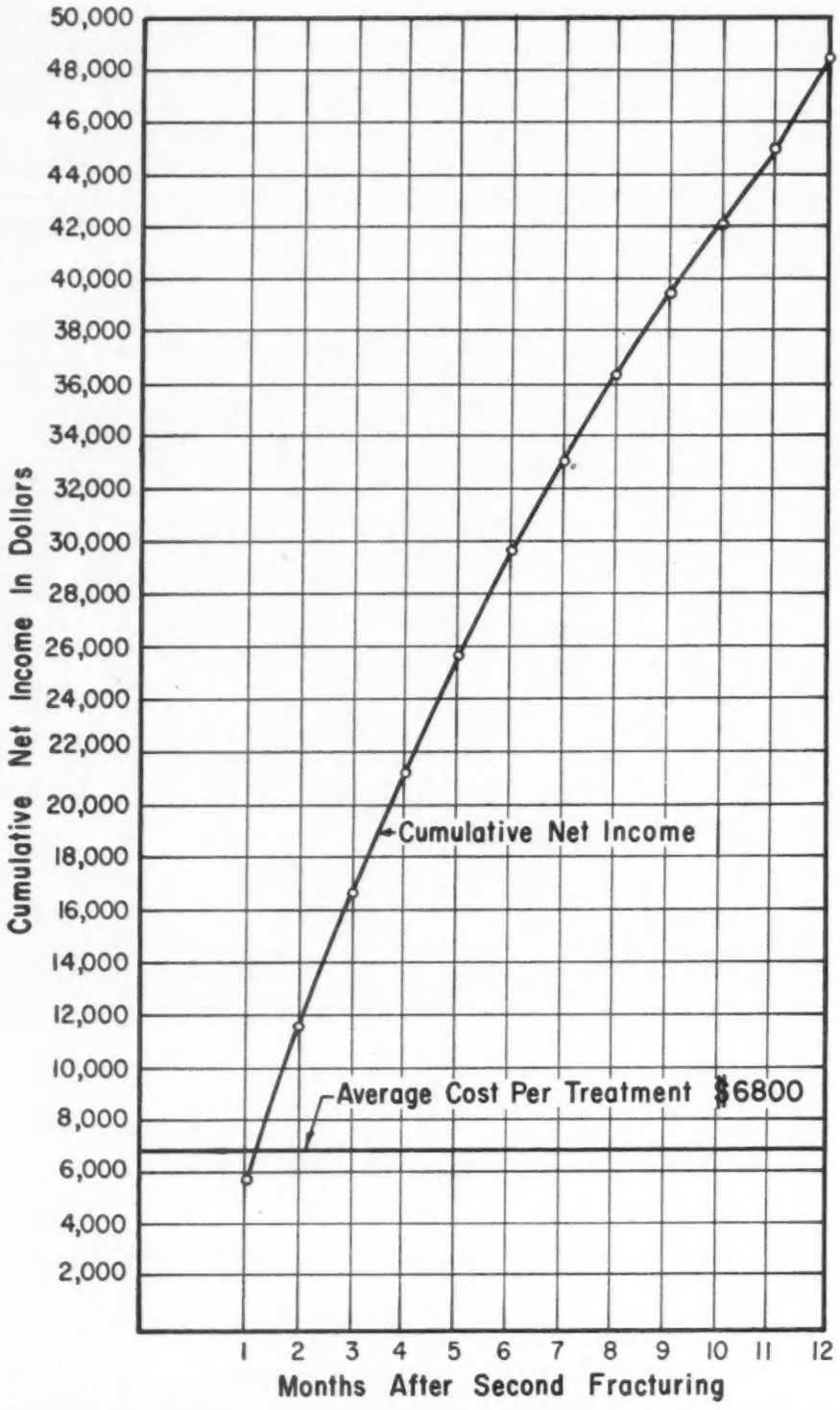

FIGURE 2—From a dollar and cents angle there seems little question of the advantages of the large-volume, high-velocity treatment in this area. The average payout time was 36 days.

secondary treatment, were placed on beam pumps after the job. In these few cases, however, the beam was used more as an agitating medium than a production medium.

Inspection of tabular data indicates some very interesting points.

Table 1 reveals pertinent data on the original completion and the secondary completion and furnishes details of the large-volume, high-velocity fracture treatments along with tests taken before and after the workover. Of the 16 wells treated, 8 had a secondary potential which was larger than the original potential. Perhaps the most outstanding was Well 11. In the 15 months after original completion it recovered 5276 barrels of oil and in the 30-month period after secondary fracture treatment, the well recovered 40,706 barrels of oil or eight times as much!

Table 2 indicates the production trend of the wells for the 12-month period prior to the secondary fracture treatment, while Table 3 reflects the producing characteristics of the wells after the secondary fracture treatment.

Table 4 shows the amount of "new" or "additional" oil recovered during the 12-month period after the secondary fracture treatment, as a direct result of the treatment. This tabulation is extremely conservative because it assumes that prior to the secondary treatment, each well had reached its maximum decline, which is not true. If the wells had not been subjected to this workover technique, decline would have continued and in some cases, the wells would have been abandoned for economic reasons. Wells Number 2, 3, 8 and 11 are classic examples. Wells Number 3 and 11, in fact, had already had AFE° submitted for plugging and abandoning and the secondary fracture treatment was applied as a "last resort."

To provide a better picture of the average productivity of these wells, as presented in Tables 2 and 3, Figure 1 was drawn.

In determining these production figures, the month in which the secondary fracture treatment was performed was omitted in order to obtain a full month's production. To insure great accuracy, no well was potentialed until all fracturing medium and flush oil had been recovered.

The cost of the jobs varied slightly at first because of a lack of proper planning. Personnel, material, storage, etc., were not coordinated thereby causing excessive rig time. After the first few jobs, however, costs were pared and streamlined resulting in savings.

On an average, a 20,000-gallon treatment using 31,500 pounds of sand cost approximately $6800. This includes the salvage value of the fracturing fluid. It is evident that the workover technique was effective and profitable.

Figure 2 shows the cumulative net profit on the 16 wells treated, for one year after the workover. Using the

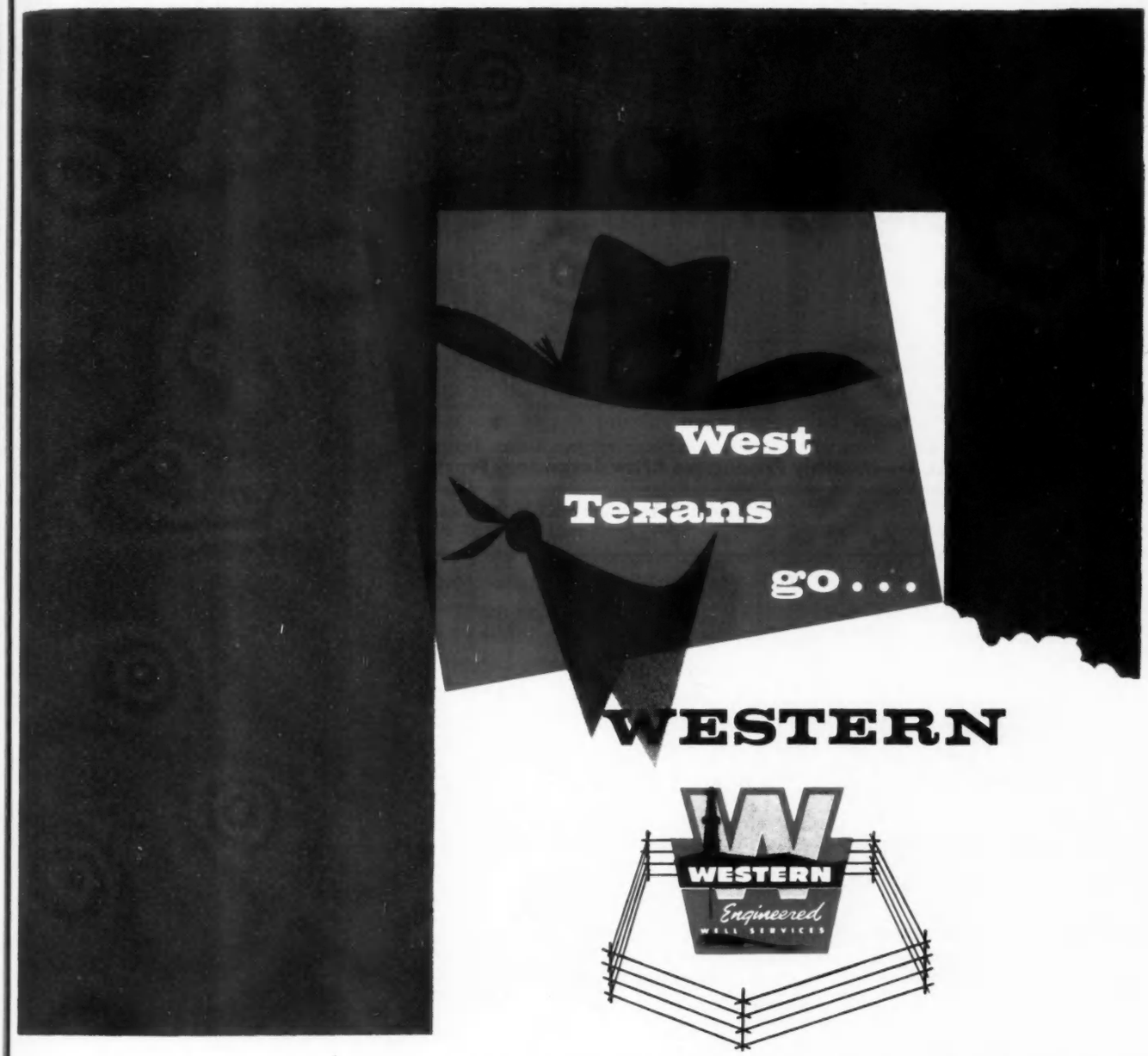

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TABLE 2—Monthly Production Before Secondary Fracture Treatment (Barrels)

Well No.	MONTHS BEFORE SECONDARY FRACTURE TREATMENT												Twelve Months Total
	12th	11th	10th	9th	8th	7th	6th	5th	4th	3rd	2nd	1st	
1	325	311	396	498	453	850	332	241	221	238	284	82	4,231
2	402	423	465	395	334	319	272	269	150	105	87	65	3,286
3	2,101	1,371	1,770	1,411	1,074	965	351	142	49	30	....	....	9,264
4	588	549	631	595	608	577	577	610	547	583	505	429	6,799
5	1,048	1,048	1,508	1,075	1,268	1,120	889	1,237	974	448	451	261	11,327
6	216	184	214	129	215	204	170	213	253	101	217	146	2,262
7	2,025	1,726	1,064	1,222	813	1,204	1,151	966	275	674	795	333	12,248
8	432	475	567	356	277	332	280	237	199	142	75	170	3,542
9	925	924	925	996	730	657	697	518	509	378	476	343	8,078
10	1,967	1,854	1,522	1,346	1,252	1,278	1,110	1,167	1,215	1,163	1,234	1,499	16,607
11	371	375	298	143	168	192	90	110	144	93	333	69	2,386
12	883	1,352	1,354	1,296	1,025	907	635	581	661	469	355	130	9,648
13	....	....	....	401	558	560	617	475	470	331	225	79	3,716
14	407	406	298	365	408	380	333	375	197	359	342	344	4,214
15	1,533	1,067	1,383	1,047	1,144	1,116	1,127	990	1,051	985	958	543	12,944
16	1,277	1,158	1,235	1,263	1,162	1,009	1,060	1,069	1,090	1,121	1,279	673	13,396
Total	14,500	13,223	13,630	12,538	11,489	11,670	9,691	9,200	8,005	7,220	7,616	5,166	123,948
Average	906	826	852	784	718	729	606	575	500	451	476	323	7,747

TABLE 3—Monthly Production After Secondary Fracture Treatment (Barrels)

Well No.	MONTHS AFTER SECONDARY FRACTURE TREATMENT												Twelve Months Total
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	
1	2,298	2,354	2,950	1,491	756	791	556	559	1,249	1,618	1,197	1,239	17,058
2	2,157	2,415	2,014	1,776	1,551	1,171	907	905	737	911	709	713	15,966
3	3,550	3,743	3,821	3,326	3,073	2,503	1,725	1,866	1,312	1,018	1,439	1,555	28,931
4	3,443	3,197	3,197	3,346	3,360	2,291	812	2,250	1,243	1,704	1,938	1,328	28,103
5	3,102	3,938	1,664	1,112	1,769	2,222	1,260	1,369	697	562	666	621	18,982
6	2,704	3,428	3,228	3,264	3,240	3,211	3,841	2,982	2,403	2,083	1,406	2,154	33,944
7	3,308	2,327	2,595	2,355	2,128	1,633	1,579	1,847	2,009	1,621	1,961	1,041	24,404
8	2,137	2,360	1,894	1,790	1,680	1,244	808	1,230	837	855	743	656	16,234
9	3,190	3,377	3,938	3,264	3,743	3,602	3,501	3,127	3,137	3,153	3,225	2,804	40,061
10	3,272	4,258	3,212	3,526	3,226	3,205	3,293	3,160	3,505	2,176	3,221	2,536	38,590
11	3,118	2,171	2,090	2,144	2,162	1,814	1,822	1,833	1,822	2,110	2,233	1,863	25,182
12	3,366	2,812	2,226	2,108	2,135	2,039	1,902	1,595	1,241	784	926	753	21,887
13	1,831	1,574	1,242	1,617	1,613	1,613	1,387	946	989	706	628	568	14,714
14	919	924	651	851	856	922	1,051	919	1,022	957	903	839	10,814
15	2,571	1,846	2,135	1,820	1,725	1,138	1,139	1,151	1,082	1,092	1,220	1,316	18,235
16	1,351	1,219	1,112	1,154	1,152	1,148	1,233	1,249	1,300	1,199	952	1,116	14,185
Total	42,317	41,943	37,969	34,938	34,169	30,547	26,816	26,988	24,585	22,549	23,367	21,102	367,290
Average	2,645	2,621	2,373	2,184	2,136	1,909	1,676	1,687	1,537	1,409	1,460	1,319	22,956

TABLE 4

Additional or New Oil Recovered During 12-Month Period After the Secondary Fracture Treatment

Well No.	MONTHS AFTER SECONDARY FRACTURE TREATMENT												Twelve Months Total
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	
1	2,060	2,116	2,712	1,253	518	553	318	321	1,011	1,380	959	1,001	14,202
2	2,092	2,350	1,949	1,711	1,486	1,106	842	840	672	846	644	648	15,186
3	3,520	3,713	3,791	3,296	3,043	2,473	1,695	1,836	1,282	988	1,409	1,525	28,571
4	3,014	2,768	2,768	2,911	2,931	1,862	383	1,821	814	1,275	1,509	879	22,955
5	2,841	3,677	1,403	851	1,508	1,961	999	1,108	436	301	405	360	15,850
6	2,558	3,282	3,082	3,118	3,094	3,065	3,695	2,836	2,257	1,937	1,260	2,008	32,192
7	2,975	1,994	2,262	2,022	1,795	1,300	1,246	1,514	1,676	1,288	1,628	708	20,408
8	1,967	2,190	1,724	1,620	1,510	1,074	638	1,060	667	685	573	486	14,194
9	2,847	3,034	3,645	2,921	3,400	3,259	3,158	2,784	2,794	2,810	2,882	2,461	35,995
10	1,773	2,759	1,713	2,027	1,727	1,706	1,794	1,661	2,006	677	1,722	1,037	20,602
11	3,049	2,102	2,021	2,075	2,093	1,745	1,753	1,764	1,753	2,041	2,164	1,794	24,354
12	3,236	2,682	2,096	1,978	2,005	1,909	1,772	1,465	1,111	654	796	623	20,327
13	1,752	1,495	1,163	1,538	1,534	1,534	1,318	867	910	627	549	489	13,776
14	575	580	307	507	512	578	707	575	678	613	559	495	6,686
15	2,028	1,303	1,592	1,277	1,182	595	596	608	539	549	677	773	11,719
16	678	546	439	481	479	475	560	576	627	526	279	443	6,109
Total	36,965	36,591	32,667	29,586	28,817	25,195	21,474	21,636	19,233	17,197	18,015	15,750	303,126
Average	2,310	2,287	2,042	1,849	1,801	1,575	1,342	1,352	1,202	1,075	1,126	984	18,945

average cost of the secondary fracture treatment, it is quite simple to reflect the "break even" point for any well workover. This assumes, of course, that wells are producing from the same formation and were subjected to a similar workover technique. The income is net and has had all expenses removed, such as lifting costs, ad valorem taxes, pipe line taxes and severance taxes. Only income taxes has not been considered. This curve clearly reflects that the average well paid off its workover costs in about 36 days and at the end of 365 days had made a net profit of about $41,565.

New techniques are being developed constantly because of the increasing efforts of the various service organizations striving to help the operator realize the most from his investment. The operator, in turn, must be willing to try a new technique or a new material because it is only through experimentation that experience is gained. —The End

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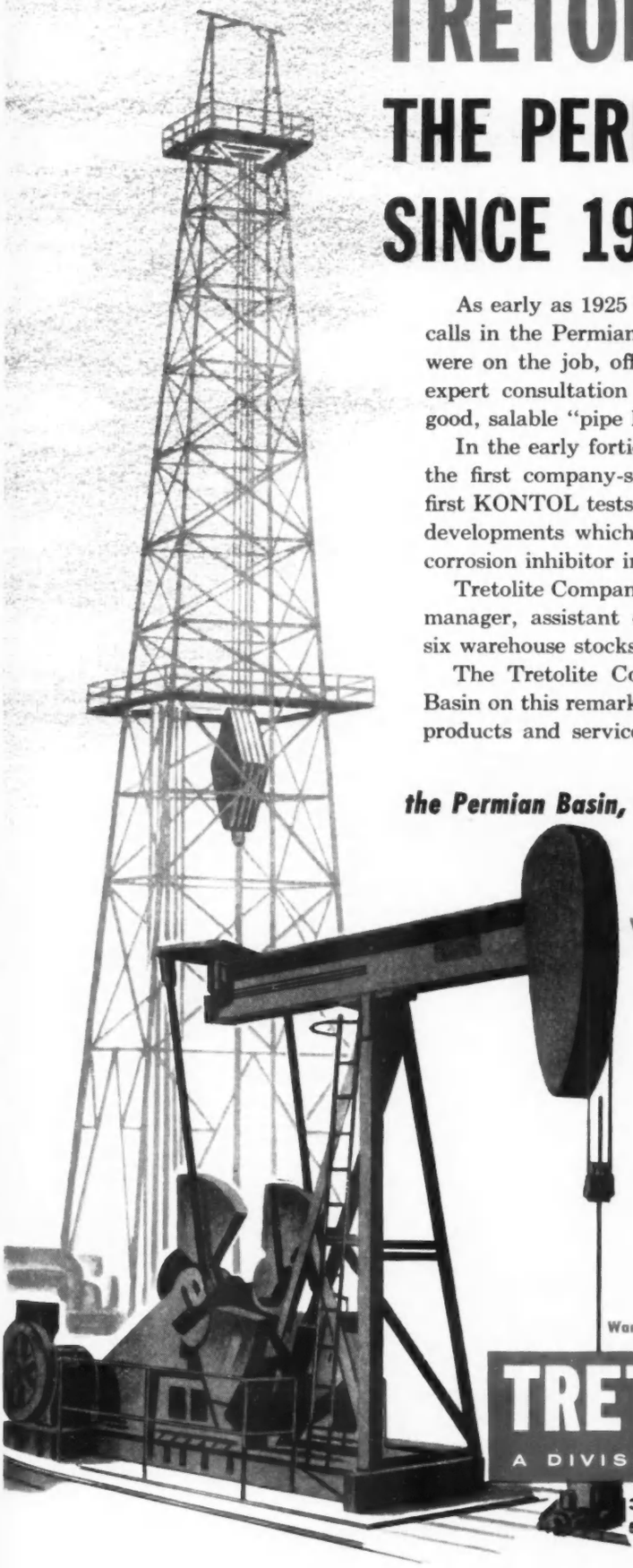

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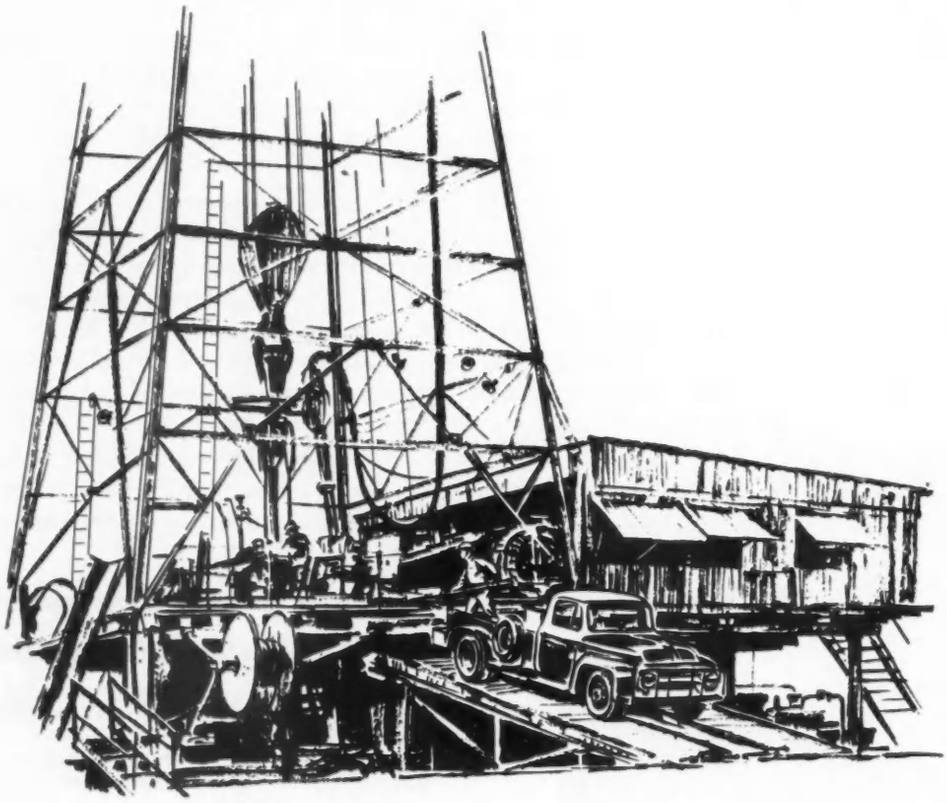

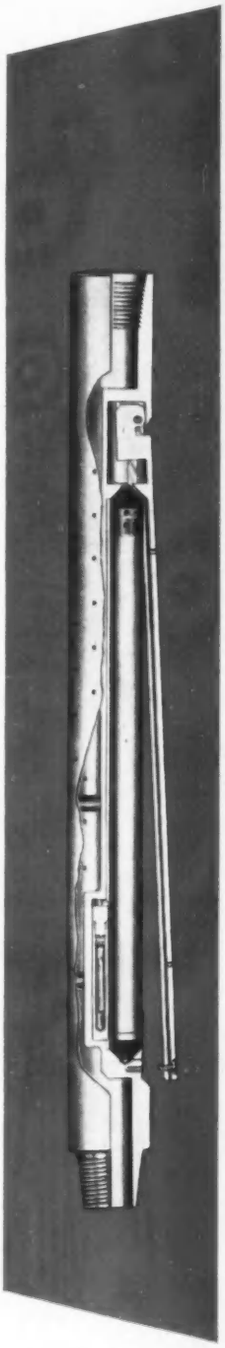

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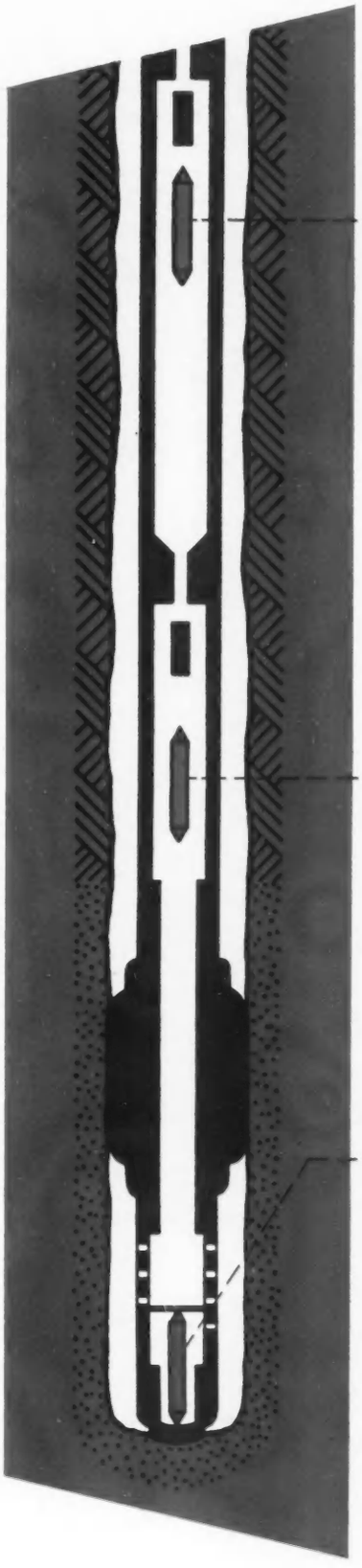

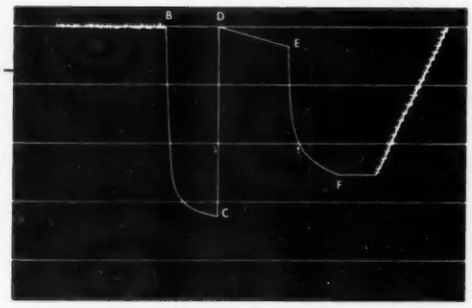

Chart From Gauge In Air Chamber

CHART DESCRIPTION

- **A** Tester Valve Opened
- **B** Mud Pressure Relieved Formation Pressure Build-Up Starts
- **B-C** Initial Closed-In-Pressure Build-Up Curve
- **C** Auxiliary Valve Opened
- **D-E** Flowing Pressure Curve
- **E** Closed-In-Pressure Valve Closed
- **E-F** Final Closed-In-Pressure Build-Up Curve

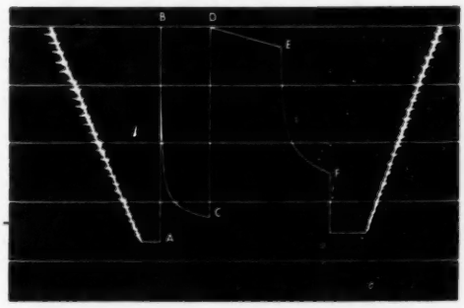

Chart From Gauge In Flow Stream Below Tester Valve

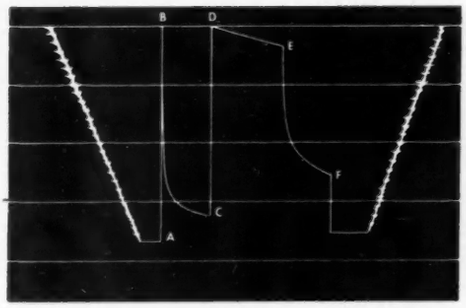

Chart From Blanked-Off Gauge

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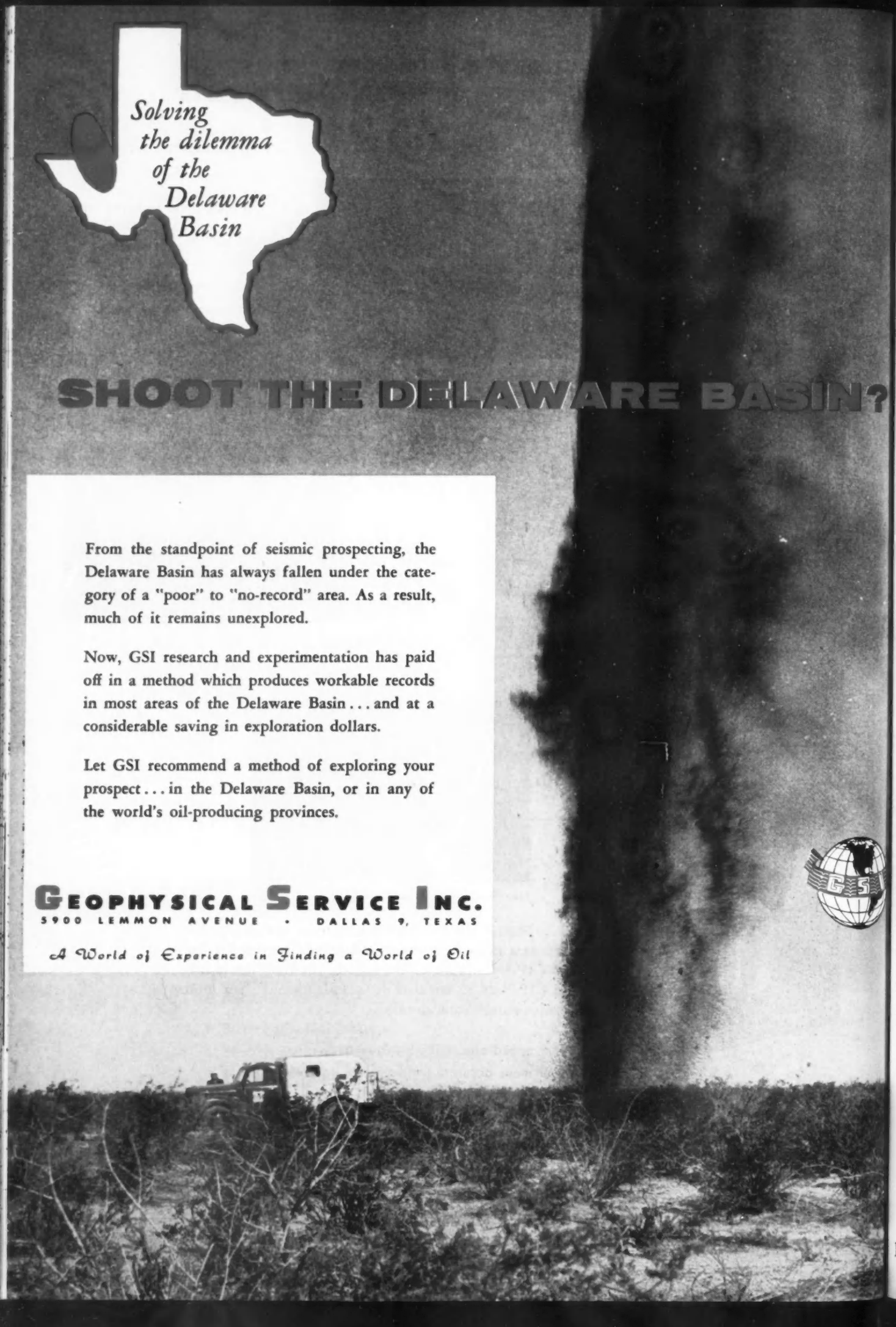

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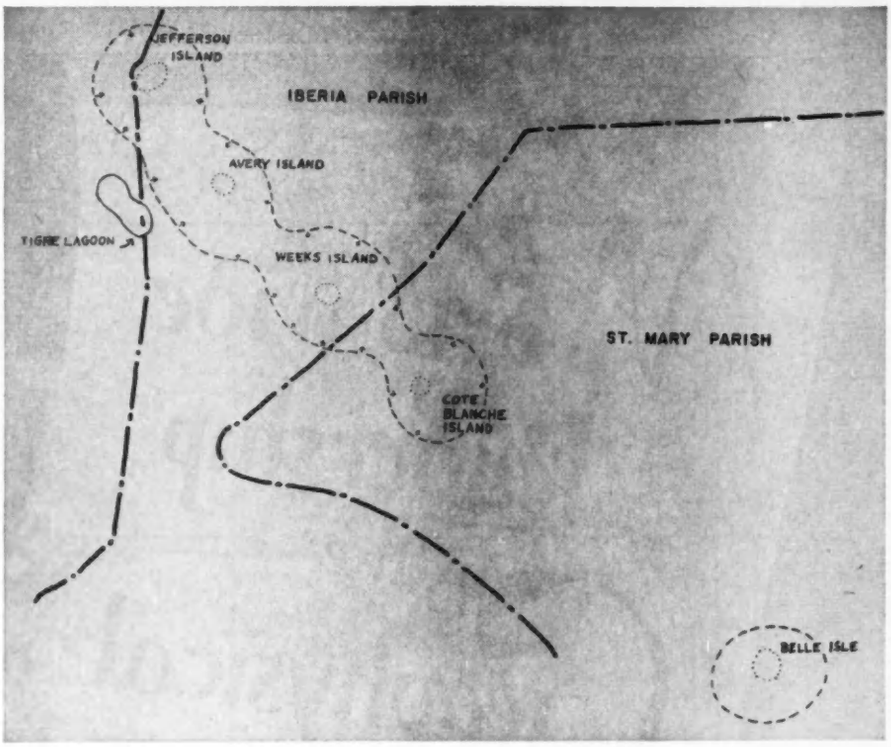


FIGURE 1—The Five Island series of structures, so named because five islands reflecting salt uplifts rise above the surrounding swamp, consists of salt domes aligned in a northwest-southeast direction with steep dip being present in all directions toward the domes from a peripheral area roughly two to three miles away.

A Neglected Objective

Because of the increasing difficulty of finding oil in the Gulf Coast area, a reappraisal of the area rimming large synclines due to salt migration is in order and considerable addition to reserves would result from increased activity in these neglected areas.

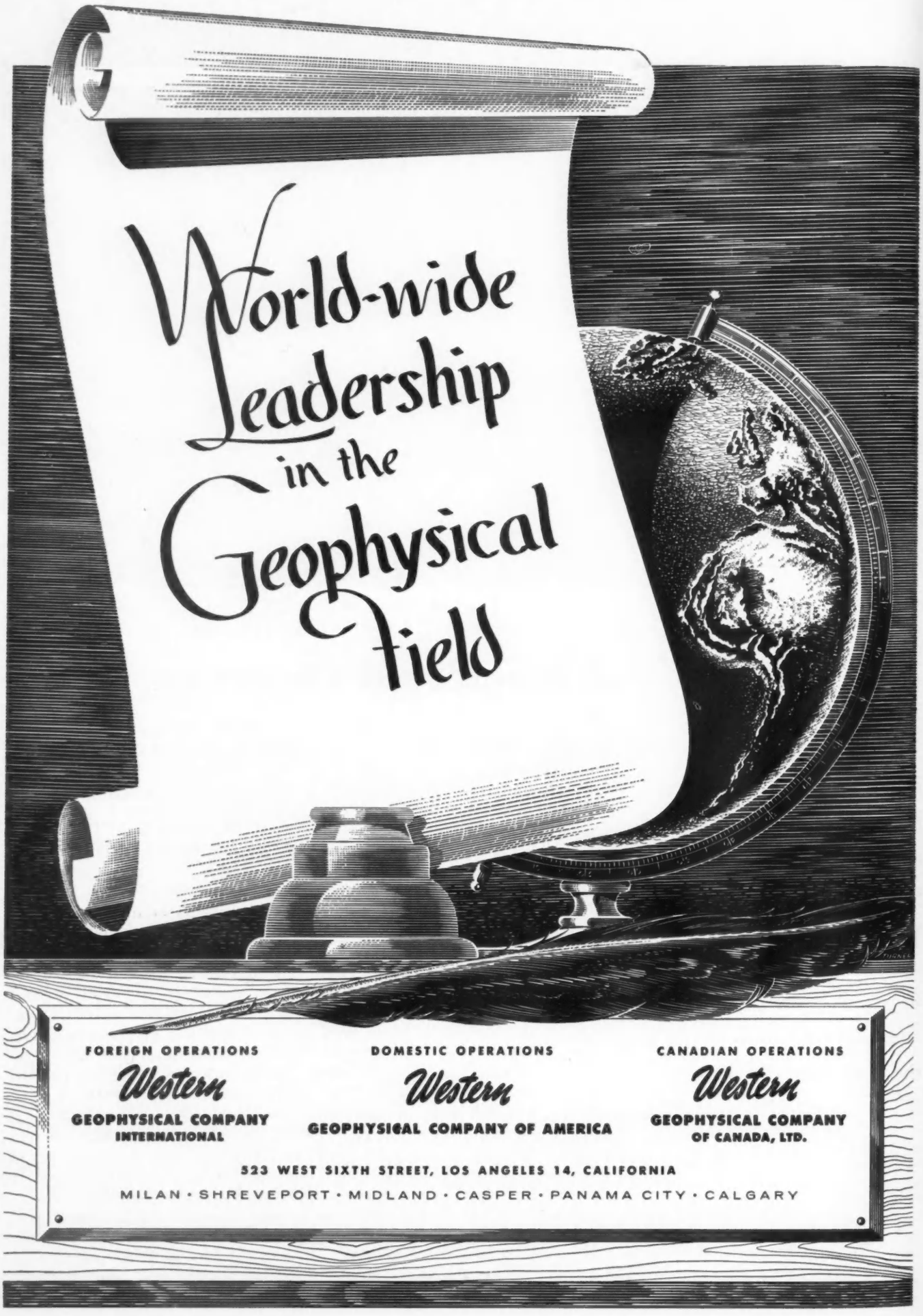
By GERRY BERNATCHEZ
New Orleans

FAULTY TRAPS HAVE long been recognized as prolific objectives in the Gulf Coast region. Although figures are not available regarding the amount of production from features directly related to faults, it is apparent that a large percentage of the production in the Gulf Coast region comes from this type structure. Production may occur from isolated, minor fault closure or from a long series of fault closures as in the Sam Fordyce—Vanderbilt fault system in Southwest Texas which reportedly has 115 distinct oil and gas fields related to it which have produced a total of one billion barrels of oil.[1]

There is considerable disagreement as to the mechanics controlling the formation of closures against depositional faults in the Gulf Coast area but it appears that they are due in part to drag against the fault resulting from the incompetent nature of the sediments. In many cases, closures occur on the downside of the fault, but in numerous cases, closures occur on the upthrown side and separate adjoining closures may be present on opposite sides of a fault. The accumulation may occur on the up or down side of the fault or, as frequently happens, on both sides.

The majority of the faults in the Gulf Coast area and virtually all having regional significance are downthrown in the direction of regional dip which is roughly toward the present coast line. A conspicuous exception to this general rule occurs in cases where large scale salt migration toward salt domes has resulted in large bordering synclines being formed.

Two well known examples of this condition in South Louisiana are in the Five Island area in Iberia and St. Mary parishes and the Calcasieu Lake Dome area in Cameron Parish. The Five Island Series of Structures, so named because five islands reflecting salt uplifts rise above the surrounding swamp, consist of salt domes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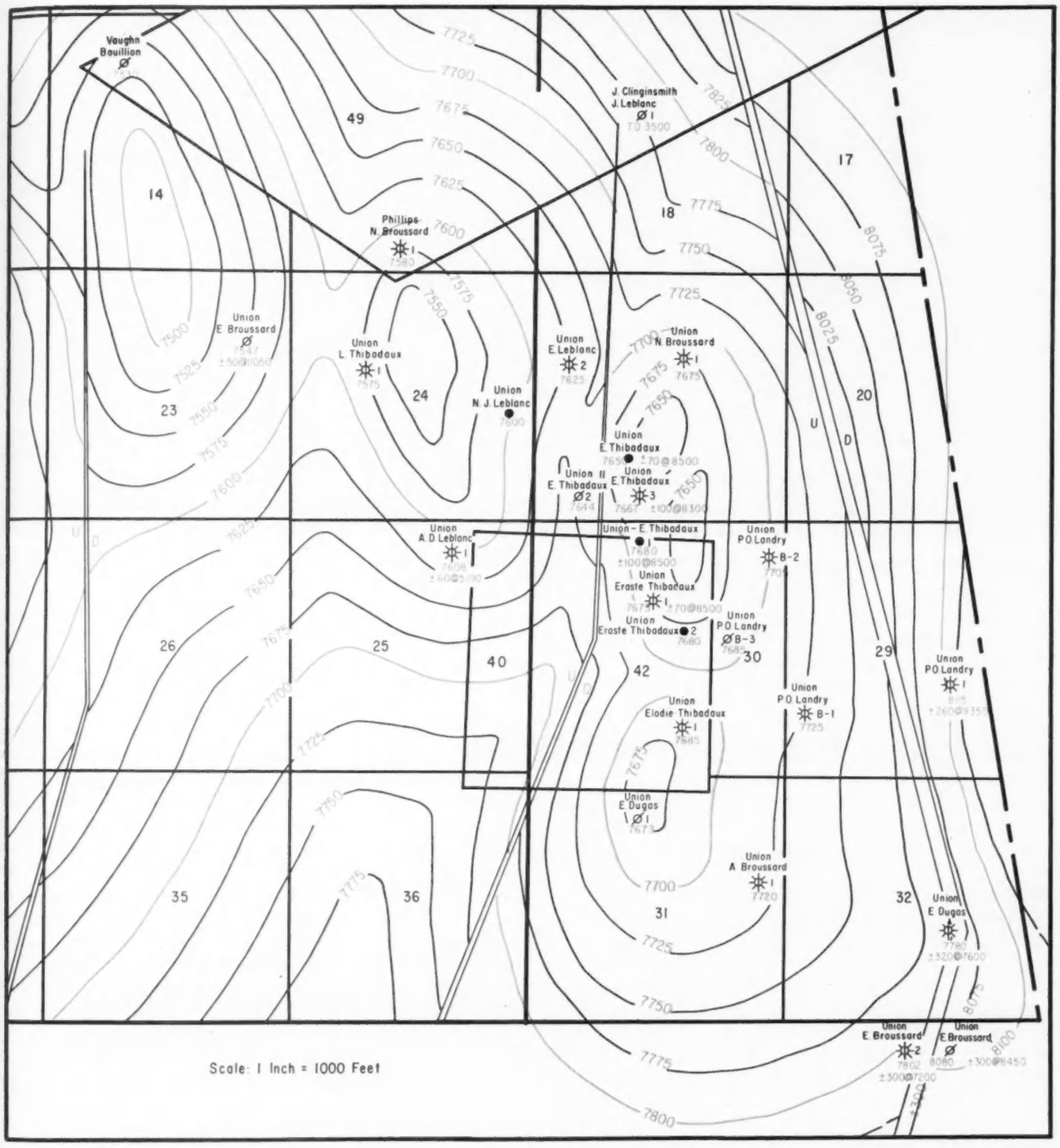


FIGURE 2—Oil migrating updip from the syncline may be trapped in structures related to the faulting. A good example of this type of accumulation is Tigre Lagoon Field in Vermilion and Iberia Parishes which lies on the western rim of the Five Island syncline. A series of north-south striking faults down-thrown to the east is present.

aligned in a northwest-southeast direction with steep dip being present in all directions toward the domes from a peripheral area roughly two to three miles away. Adjustment faulting downthrown in the direction of steep dip is present in the peripheral area. Oil migrating updip from the syncline may be trapped in structures related to the faulting. A good example of this type of accumulation is Tigre Lagoon field in Vermilion and Iberia parishes which lies on the western rim of the Five Island syncline. A series of north-south striking faults downthrown to the east is present. Surprisingly few fields of this type have been discovered in South Louisiana probably since very little drilling has been done in the type of area under discussion. Seismic interpretation is difficult in areas of this type due to the extremely steep dips present. As a result, operators have concentrated their drilling activity on known domes or in adjoining areas where seismic data may be more reliably interpreted.

ACKNOWLEDGMENT

[1] John W. Honea—*Transactions*, Vol. VI, p. 51, Gulf Coast Association of Geological Societies.

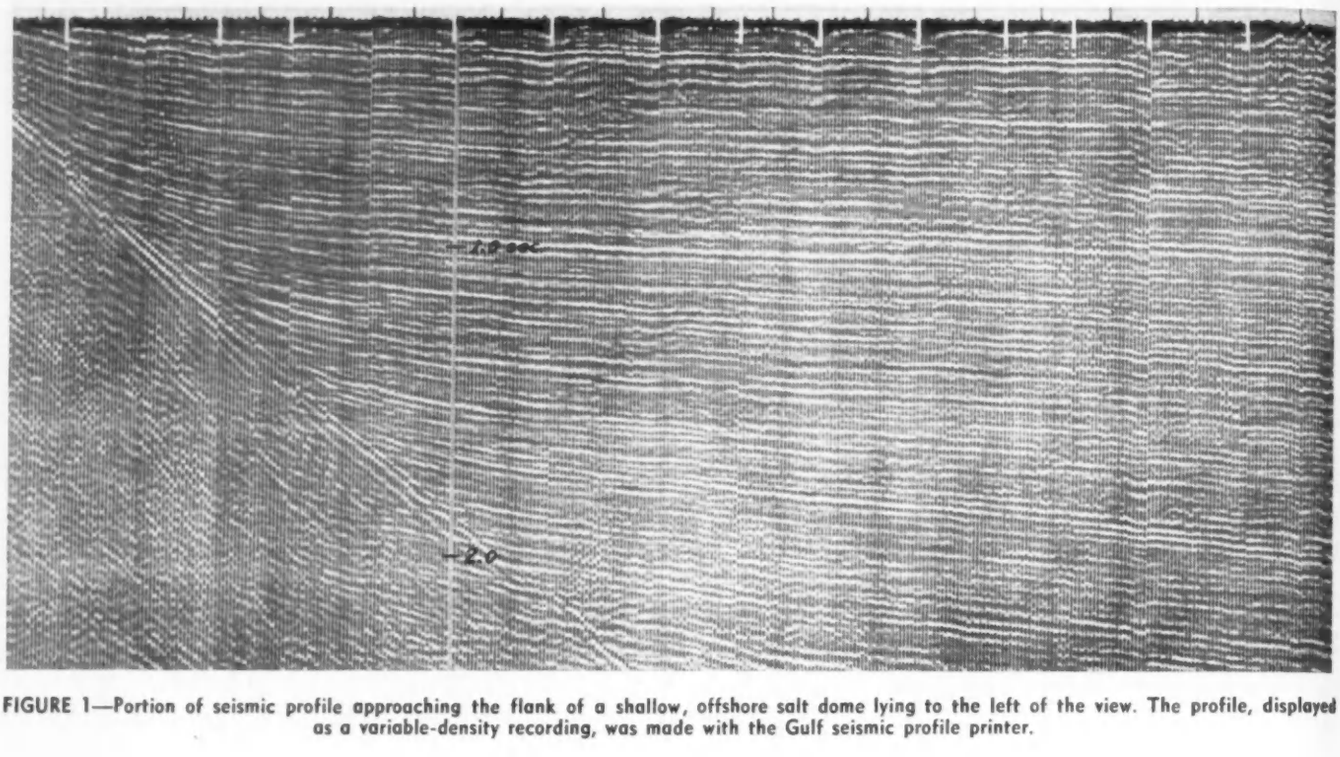


FIGURE 1—Portion of seismic profile approaching the flank of a shallow, offshore salt dome lying to the left of the view. The profile, displayed as a variable-density recording, was made with the Gulf seismic profile printer.

Looking Inside the Earth

The system of variable-density profile presentation of seismic data is proving to be of great value in Gulf's geophysical operations.

THE SEISMIC PROFILE system developed by the Gulf Research & Development Company graphically displays on a photographically printed profile the complete seismic data recorded along a continuous traverse. On this profile print, which constitutes a section profile of unrestricted length, the data are reproduced on closely spaced, parallel tracks as variations in photographic density. The seismic events on each of the profile tracks are printed in corrected positions with respect to a conveniently chosen datum, which is recorded as a line across the top of the section.

The corrections, applied individually on each printed track, take account of surface elevations, weathering, and other fixed factors and of stepout, which varies progressively along the track. The effect of changing average wave-front velocity with increase in time is provided for in the stepout correcting mechanism. Data upon which the corrections are based are quickly inserted into the mechanism on punched cards, and the entire operation of printing each of the successive field records in a specially designed printer is automatic.

The resulting profile section bears a close resemblance to a geologic cross-section, for the seismic events are distinctively displayed by the variable-density method of reproduction. The seismic picture of the entire profile may be absorbed at a glance. Paper prints, readily made from the profile film, are generally used for working out interpretation details and preparation of maps.

Figures 1 and 2 show portions of seismic profiles made by the Gulf profile printing system and illustrate the clarity and completeness of the information revealed along a continuous traverse. The profile of Figure 1 approaches the flank of a shallow, offshore salt dome lying to the left of the photograph; and the profile of Figure 2 extends over a deeper dome. Timing marks indicated on the profiles at 1.0, 2.0, and 3.0 seconds are with respect to the datum line (not shown in these views). The complete profile allows about 3.8 seconds of recording time. In each photograph the bending of the sediments upward toward the salt mass is indicated clearly. In Figure 2 the strong reflection alignments at about 1.25 seconds are evidently repeated at 2.5 seconds as multiple reflections (events making a second round trip, having been reflected from the surface of the water). Events below 1.25 seconds must also be multiple reflections of earlier-arriving events.

The rendition of seismic data in this manner simplifies the work of those interpreting such data, draws attention immediately to the geophysically important and noteworthy features of the data and assures that all detail, which may be so clearly observed, is given careful consideration for its contribution to the over-all seismic picture.

The variable-density tracks on the original field records look much like those on the profile which is eventually made from them. Corresponding to each oscillographic trace of a conventional record, there is one variable-density track or channel. On the film, 70 mm in width, there are 27 tracks side by side, one-twelfth inch from center to center. Twenty-four channels are used for seismic information. The other three tracks are for auxiliary information, such as time break and 100-cps timing.

In the interpretation of oscillographic records, it has been customary in the past to laboriously plot selected seismic events in corrected position on graph paper. In distinction from this, the Gulf system employs a "profile printer," shown in Figure 3, which applies the corrections to all events of individual tracks of successive field records and prints the corrected events on a photographic film 20 inches wide and up to 100 feet long to form the complete profile section. In the printing steps data reduction and various special functions are performed automatically.

The profile film is threaded around a small roller on the film magazine, which is inside the center portion of the chassis. When the printer is in operation, the variable-density record is held in tangential contact with the profile film along the upper side of the roller. As a profile track is exposed, a narrow illuminated slit moves along the roller at a steady rate, and light is transmitted through the particular record track which is in contact with the film. Thus the varying densities on the record track are transferred to the profile film to form one profile track.

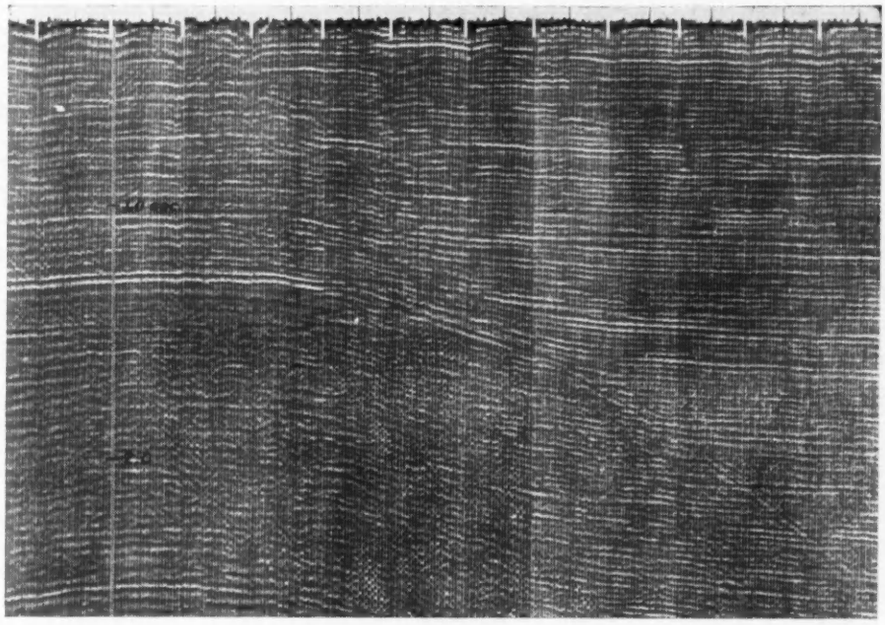


FIGURE 2—Portion of variable-density profile made with Gulf seismic profile printer from seismic records shot over an offshore salt dome.

Before the next traverse of the illuminated slit along the roller, the record is moved sideways one track, and the film is advanced one profile increment. Accordingly, successive tracks are printed one at a time, and the process is continued for all tracks of a record and all records of a profile.

The fixed correction, which applies to the entire length of a record track, is introduced by a fixed displacement of the record along the roller, and the varying densities of the record track are appropriately displaced on the profile film. The values of the fixed correction for all tracks of a record are previously punched on a 3 inch by 4 inch card, which is inserted into the printer at the time a record is loaded. The record is displaced automatically just prior to the printing of each track in accord with the hole locations. Such corrections may exceed plus or minus 280 milliseconds relative to the chosen datum.

The variable, or stepout correction, which applies differentially along the length of a record track, is automatically calculated during the printing process. The mechanism gradually displaces the record and progressively shifts in time the printing position of the record-track signals on the profile film. Part of the information on which the stepout correction is based is punched in a second card, which is also inserted into the printer when a record is loaded. The effect of changing wave-front velocity with increasing time along the profile track is introduced by a cam, which is appropriately shaped for the velocity conditions on the traverse. One cam only is required for the printing of all the tracks of a profile in a given area.

The basic elapsed time for the print-

Continued on Page 190

Illustrations Courtesy Gulf Research & Development Co.

FIGURE 3—Gulf seismic profile printer showing operator setting a control switch on the main control panel and some of the printing mechanism. The cover is closed when the printer is in operation.

Oil Possibilities Seen in Williston Basin's

The stratigraphic column of the area is made up of sedimentary rocks that range in age from Cambrian to Recent.

By A. ROWLAND BOUCHER, CARL A. MORITZ and WAYNE E. SWEARINGEN

Alex W. McCoy Associates, Inc.
Tulsa

THE SOUTHWESTERN FLANK of the Williston Basin is one of the most important remaining frontiers for exploration in the Rocky Mountain province.

The reasons for this conclusion:

- Structural and stratigraphic conditions are favorable for the generation, accumulation and trapping of commercial quantities of oil and gas.
- A major positive structural feature is interpreted from subsurface data to be an extension of the producing anticlinal trends of southeastern Montana. This tectonic feature influenced sedimentation throughout Paleozoic and part of Mesozoic time.
- There are 15 possible pay zones, all known to produce oil and gas in the bordering states of Montana, North Dakota and Wyoming, and all of which can be tested at depths of less than 12,000 feet.
- Encouraging shows of oil and gas have been encountered in most of the tests in the area, and production has been established in the Red River formation, this despite the fact that so few wells have been drilled.
- The area has not been adequately evaluated by drilling. Well density is one test per 18.6 square miles or one test per 120,000 acres.

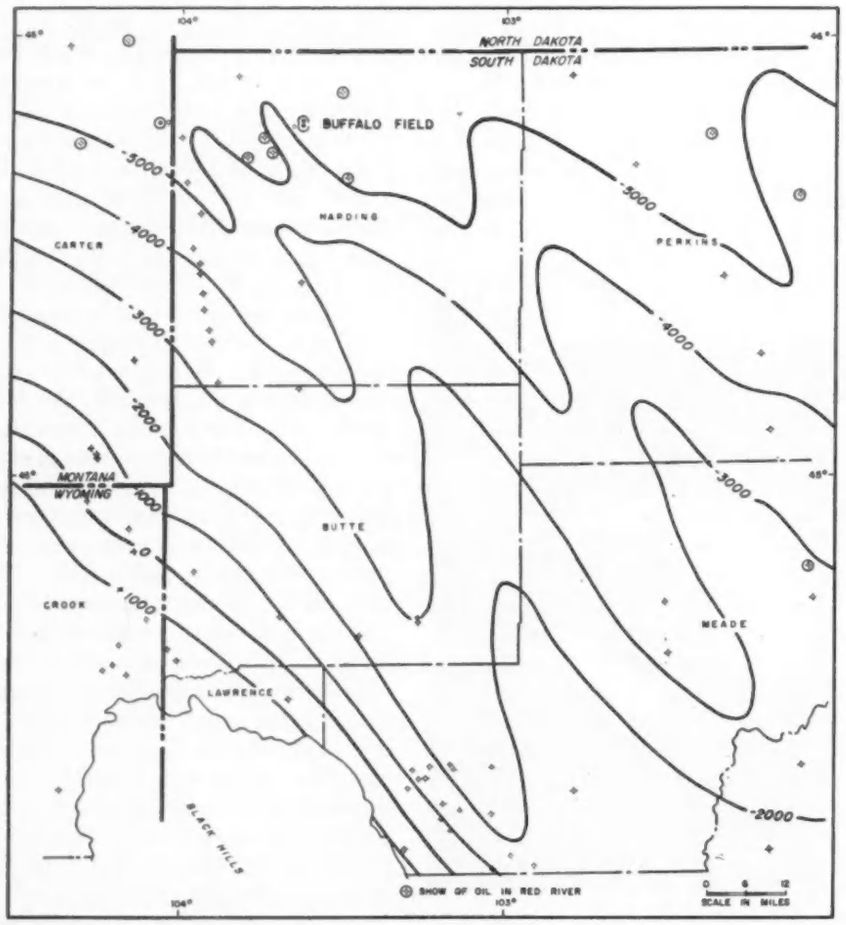


FIGURE 1—Structure contour map on top of Pennsylvanian-Minnelusa formation in the southwestern flank of the Williston Basin. Contour interval is 1000 feet.

Location. The region discussed in this article (referred to by some writers as the Lemmon Syncline) also includes a portion of the northwestern extension of the Black Hills Uplift. The area of interest is made up of portions of Crook County, Wyoming, Carter County, Montana, and all, or portions of, Lawrence, Meade, Pennington, Perkins Butte and Harding counties, South Dakota.

History of Drilling Activity. The first exploratory drilling in western South Dakota for which there is any record took place in 1927. The Cosden Petroleum Company drilled their No. 1 State, T 9 N., R. 17 E., Meade County. The well was drilled to a total depth of 2790 feet and completed as a water well in the Lakota sandstone of the Cloverly group. No shows of oil or gas were reported.

Subsequent drilling activity (through 1956) in this province is summarized in Table 1.

At the present time there are five wells drilling in South Dakota. They are: Shell Oil Company No. 1 Graves, T. 21 N., R. 4 E., Harding County; Shell Oil Company No. 1 Johnson, T. 21 N., R. 8 E., Harding County; Pure Oil Company No. 1 John Walker, T. 2 N., R. 10 E., Pennington County; Phillips Petroleum Co. No. 1 Dunn, T. 2 N., R. 9 E., Pennington County.

In the Montana portion of the area,

SW Flank

11 important wells have been drilled to date over the eight-year span from 1948 to 1956. Table 2 summarizes this activity.

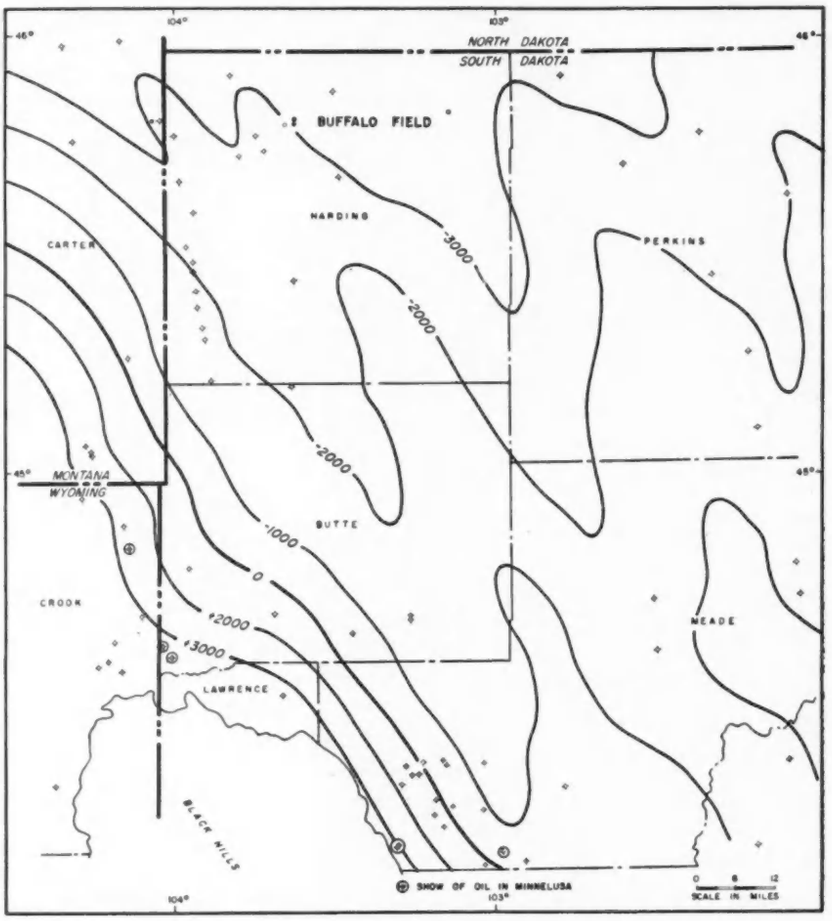
A total of nine wells have been drilled in the Wyoming portion of the study area. At this writing, oil and gas have not been found in commercial quantities in the Wyoming portion of the region.

GEOLOGY

Structure. The area of interest is situated on the southwestern flank of the Williston Basin, which is often referred to as the Lemmon Syncline. The Williston Basin proper includes all of western North Dakota and extends northward into Saskatchewan and westward into Montana. The Cedar Creek or Baker-Glendive anticline is found along the western margin of the basin in eastern Montana and extends into the southwestern corner of North Dakota. The Black Hills Uplift is centered in Lawrence County, South Dakota. A northwestern extension of this uplift forms a structural platform in northeastern Wyoming and southeastern Montana.

The structural configuration on the top of the Pennsylvanian-Minnelusa formation is depicted on Figure 1. It shows relatively steep and uniform northeast dips on the northeastern flank of the Black Hills Uplift. To the northeast there are three broad, parallel, northwesterly plunging anticlinal noses.

The structure on the top of the Ordovician-Red River formation is shown on Figure 2. Red River structure is similar to that on the top of the Minnelusa formation. The two major structural axis northeast of the flank of the Black Hills Uplift are



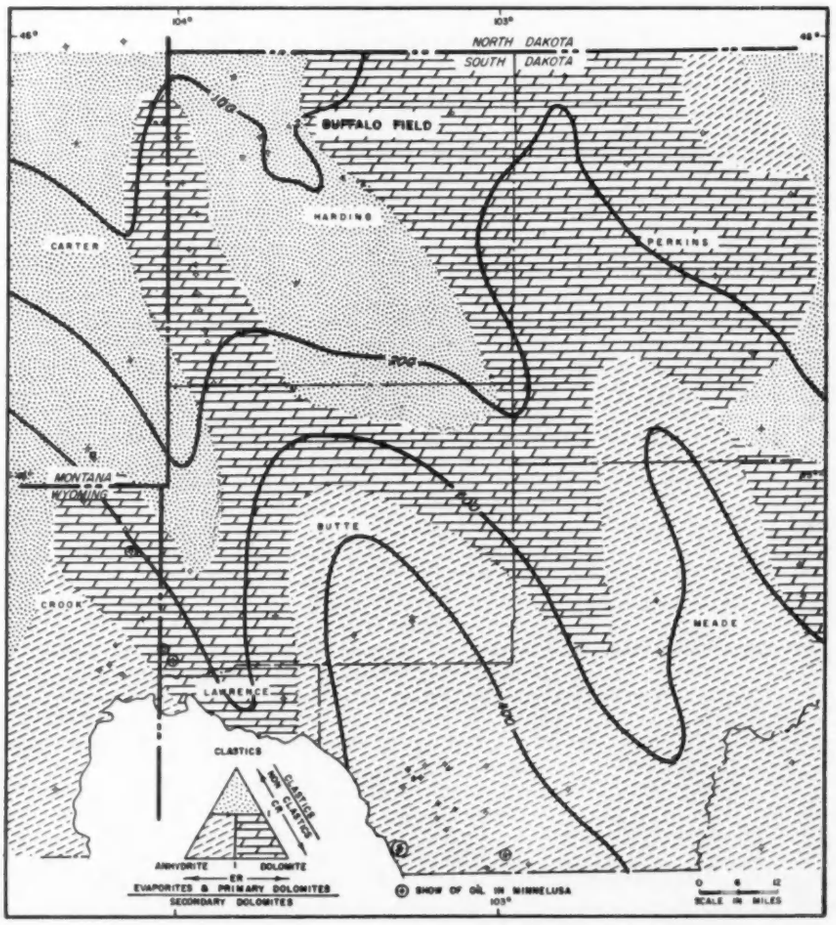


FIGURE 2—(top) Structure contour map on top of Ordovician Red River formation. Contour interval is 500 feet.

FIGURE 3—(bottom) Isopachous and lithofacies map of Minnelusa formation. Isopachous interval is 100 feet.

farther to the west on the Red River datum.

The most prominent axis (Figure 2) is interpreted to be an extension of the major anticlinal trends of southeastern Montana.

In addition to the major structural features shown on these maps, there are a number of smaller anticlines that have been mapped on the surface, but these are not reflected by the scale and contour interval of regional maps.

TABLE 1

Year	Company	Location	Deepest Horizon Penetrated	Total Depth	Oil and Gas Occurrence	Result
1931	Gypsy Oil Company	3N-16E	Mississippian	5001		D & A
1931	N. W. Development	20N-1E	Cretaceous	2002		D & A
1932	Bear Butte Oil Company	6N- 6E	Igneous	830		D & A
1933	Wytex Oil Company	8N- 1E	Minnelusa	1529	Minnelusa	D & A
1935	Norbeck Drilling Company	23N-16E		1116		D & A
1935	U. S. Department Agriculture	9N- 5E	Minnelusa	4400		D & A
1940	States Royalty	18N- 1E	Cambrian	7908	Mississippian Winnipeg	D & A
1941	Northern Ordnance	11N- 1E	Ordovician	4533		D & A
1945	Northern Ordnance	15N- 2E	Ordovician	7038		D & A
1945	Arp Company	3N- 7E	Minnelusa	No data available		D & A
1949	Seyler Oil Company	8N- 5E		705		D & A
1949	E. B. Kucera	3N- 7E	Minnelusa	1370	Minnelusa	D & A
1950	Morton Oil and Amerada	2N- 9E	Dakota	2408		D & A
1950	E. B. Kucera	3N- 7E	Mississippian	2155		D & A
1950	E. B. Kucera	3N- 7E	Minnelusa	1235		D & A
1950	E. B. Kucera	3N- 7E	Red Beds	400		D & A
1950	Morton Oil and Amerada	3N- 9E	Mississippian	4202	Minnekahta	D & A
1950	Morton Oil and Amerada	5N- 8E	Cretaceous	2134		D & A
1950	Morton Oil and Amerada	5N- 9E	Cretaceous	2420		D & A
1950	Seyler Oil Company	8N- 5E	Cambrian	5759		D & A
1950	Tee Pee Buttes Oil Company	9N- 7E	Cretaceous	2752		D & A
1950	Tee Pee Buttes Oil Company	9N- 7E		1400		D & A
1951	Morton Oil	2N-10E	Dakota	2475		D & A
1951	Weller-Bush Corporation	7N- 4E	Cambrian	3143	Minnekahta	D & A
1952	E. B. Kucera	3N- 7E	Minnelusa	1280	Minnekahta ?	D & A
1952	Shell Oil Company	17N-15E	Precambrian	8317		D & A
1952	Shell Oil Company	20N-12E	Precambrian	9348	Cretaceous Mission Canyon	D & A
1953	J. P. Evans	13N-16E	Precambrian	7318		D & A
1953	Amerada Petroleum	14N- 4E	Cambrian	7772	Minnelusa	D & A
1953	Carter Oil Company	20N- 3E	Ordovician	9052	Red River	D & A
		20N- 1E	Cretaceous	2002		D & A
1953	Hunt Oil Company	20N- 3E	Cambrian	9045	Mission Canyon Lodgepole Red River	D & A
1953	Youngblood & Youngblood	21N-14E	Cambrian	8569	Charles Mission Canyon Red River	D & A
1954	Lion Oil Company	4N-11E	Mississippian	4346		D & A
1954	R. R. Harmon	8N- 1E	Minnelusa	1475	Minnelusa	D & A
1954	Amerada Petroleum	16N- 1E	Cretaceous	3994		D & A
1954	Youngblood & Youngblood	19N-17E	Ordovician	7830	Charles Mission Canyon	D & A
		19N- 1E	No data available			D & A
1954	Shell Oil Company	21N- 4E	Ordovician	9335	Red River Mission Canyon	Oil
1954	Shell Oil Company	21N- 4E	Ordovician	8720	Red River	Oil
1954	Stanolind Oil and Gas	22N- 2E	Cambrian	9304	Red River	D & A
1954	W. H. Hunt—Zack Brooks	22N-11E	Cambrian	9431	Red River	D & A
1955	Shell Oil Company	1N-10E	Morrison	2808		D & A
1955	Shell Oil Company	1N-12E	Morrison	2995		D & A
1955	True, Fulton, Reserve Drilling	5N-17E	Cambrian	5575		D & A
1955	Amerada Petroleum	16N- 2E	Cretaceous	3640		D & A
		16N- 2E	Cretaceous	3865		D & A
1955	Richfield Oil Company	17N- 1E	Ordovician	8236		D & A
1955	Hunt Oil Company	18N- 1E	Ordovician	7901	Cretaceous Newcastle Mission Canyon	D & A
1955	Shell Oil & Carter Oil	21N- 3E	Cambrian	9050	Red River	D & A
1955	Sun Oil Company	22N- 5E	Ordovician	9365	Mission Canyon Red River	D & A
1956	Phillips Petroleum Company	3N- 8E	No data available			D & A
1956	Phillips Petroleum Company	4N- 8E	No data available			D & A
1956	Phillips Petroleum Company	4N- 9E	No data available			D & A
1956	Shell Oil Company	10N- 1E	Cambrian	4533		D & A
		10N-17E	Ordovician	5640	Mission Canyon Red River	D & A
		10N- 6E	Cretaceous	2725		D & A
		12N- 2E	Cretaceous	3227		D & A
1956	Amerada Petroleum	15N- 2E	Cretaceous	3450		D & A
1956	Amerada Petroleum	17N- 1E	Cambrian	8360		D & A
		17N- 1E	Ordovician	7998		D & A
1956	Ohio Oil Company	21N- 1E	Cambrian	8894		D & A
1956	Shell Oil Company	20N- 5E	Ordovician	8500 ?	Red River	D & A

TABLE 2

Year	Company	Location	Deepest Horizon Penetrated	Total Depth	Oil and Gas Occurrence	Result
1948	Hunt Oil Company	8S-57E		1135		D & A
1948	Hunt Oil Company	8S-57E	Cretaceous	1640		D & A
1948	Hunt Oil Company	8S-57E	Cretaceous	1849		D & A
1949	Amerada Petroleum	4S-57E	Minnelusa	5310		D & A
1949	Amerada Petroleum	5S-57E	Minnelusa	4812		D & A
1950	Amerada Petroleum	5S-57E	Ordovician	6462		D & A
1953	Carter Oil Company	2N-61E	Cambrian	10143	Red River	D & A
1954	Warren Petroleum Company	1S-60E	Cambrian	8600		D & A
1955	Union Oil Company	6S-57E	Cambrian	7215		D & A
1956	Ohio Oil—Texas Pacific	1S-61E	Cambrian	9362	Red River	Oil
1956	Ohio Oil—Texas Pacific	1S-62E	Ordovician	9110	Red River	D & A

Detailed surface and geophysical mapping will undoubtedly reveal the presence of other closed anticlines and anticlinal noses.

Stratigraphy. The stratigraphic column of the area is made up of sedimentary rocks that range in age from Cambrian to Recent. Except where erosion and/or non-deposition has resulted in unconformable relationships, the entire stratigraphic column from Cambrian to Recent is present. The maximum thickness of sedimentary rocks in this area exceeds 12,000 feet.

The general stratigraphy of the Williston Basin area will not be reviewed here since it has been discussed by several authors. However, stratigraphy as it pertains to known oil occurrence is summarized.

Cretaceous. Shows of oil have been reported in the Newcastle sandstone member of the Graneros shale. The Newcastle is made up of white, tan, light-brown and cream, fine-to-medium grained sandstones interbedded with black and gray carbonaceous and lignitic shale.

PENNSYLVANIAN

Minnelusa Formation. The lithology of the Minnelusa in this area is quite variable. The Upper Minnelusa (Tensleep) is composed of gray to red, fine to coarse-grained sandstone, gray to pink, finely crystalline to dense slightly cherty limestone and dolomite and reddish, blocky shale with some anhydrite. The Lower Minnelusa (Amsden) is composed of mottled cryptocrystalline-to-lithographic dolomite interbedded with red shale and evaporites. Figure 3 is an isopachous and lithofacies map of the Minnelusa formation. The thickness of the unit ranges from less than 100 to more than 400 feet in the area. The greatest thickness and highest evaporite ratio occurs directly northeast of the Black Hills. Clastic ratios increase toward the northeast and northwest. Shows of oil occur where the evaporite ratios are relatively high and the clastic ratios are relatively low. The Minnelusa thins across the anticlinal feature which plunges northwestward through Meade and Harding counties, South Dakota. The Minnelusa lithologies in this part of the area are similar to those in extreme western South Dakota and eastern Wyoming where occurrence of oil is known. This area exhibits a combination of structure

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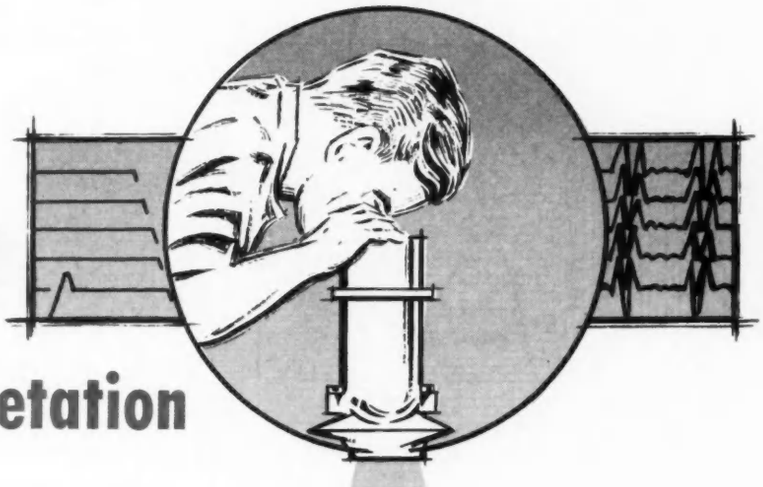

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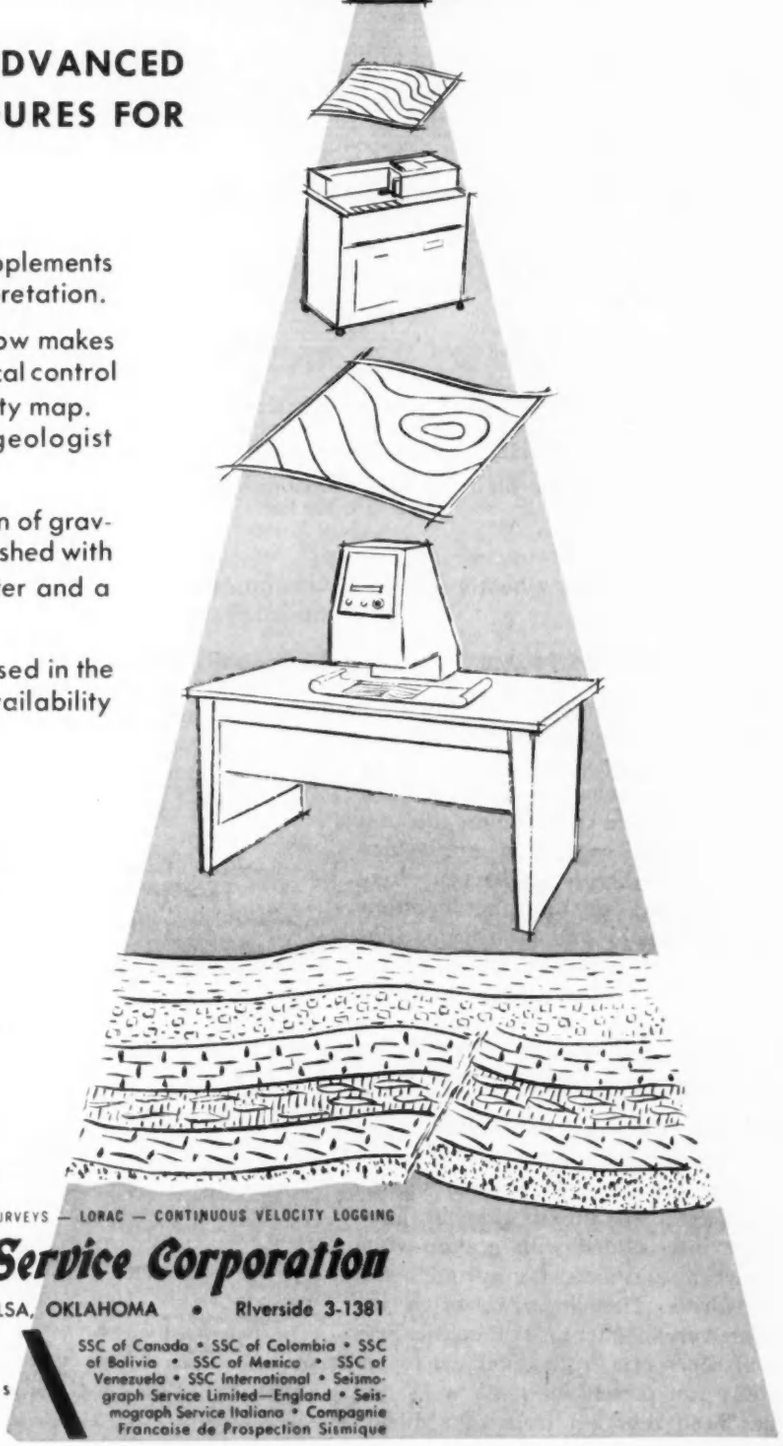

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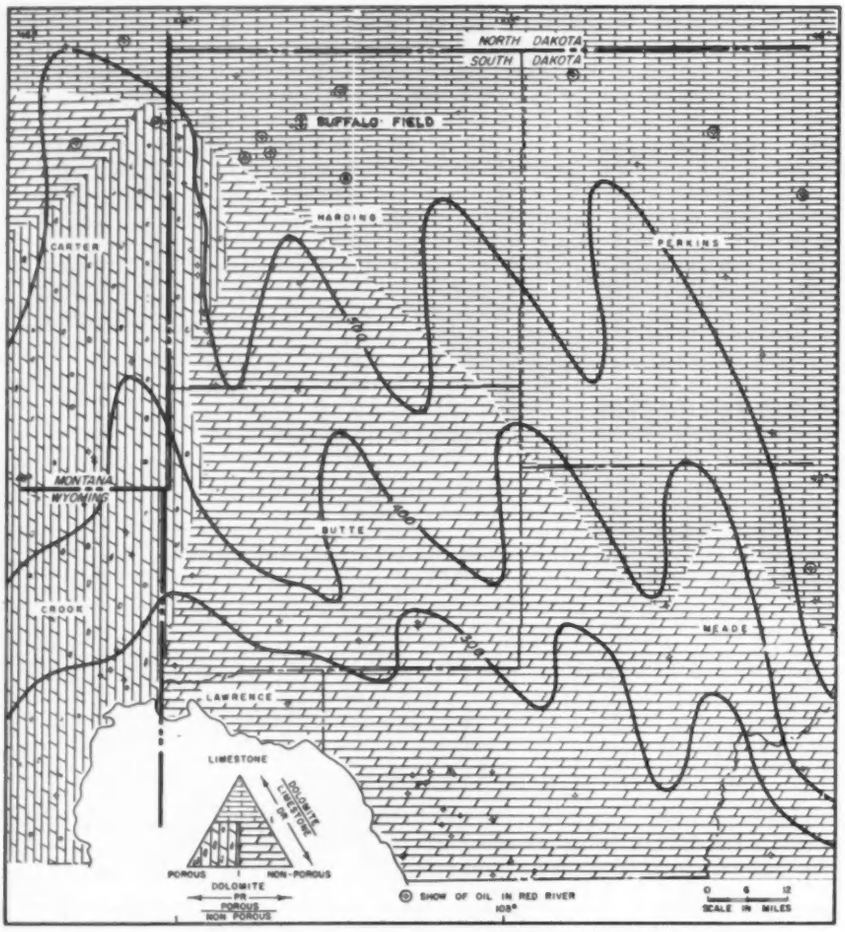


FIGURE 4—Isopachous and lithofacies map of Ordovician Red River formation. The contour interval is 100 feet.

and stratigraphy favorable for Minnelusa oil production.

MISSISSIPPIAN

Charles Formation. The Upper Charles formation is a mottled, cream, tan, brown and pink, dense slightly argillaceous limestone with sparsely interbedded red shale. Below this unit the formation consists of interbedded gray-to-tan, slightly argillaceous dolomite, mottled gray and pink limestone and red shale and anhydrite. The basal unit is usually gray-to-white anhydrite with thin beds of tan dolomite. Several wells in the area have encountered oil shows in dolomites of the Charles formation.

Mission Canyon Formation. The Mission Canyon formation is made up of interbedded light brown, slightly fragmental to sublithographic limestone interbedded with gray-to-white anhydrite and mottled gray and brown anhydrite. The limestone often become very fossilferous and oolitic. Several zones of fair to good vuggy porosity are present in some wells. Oil has been reported from the Mission Canyon formation in many wells drilled in the area.

Lodgepole Formation. The Lodgepole formation is made up primarily of gray, brown and mottled gray and brown, dense, sublithographic argillaceous and cherty limestone, with sparsely interbedded gray and brown argillaceous dolomite and dolomitic limestone. It ranges in thickness from about 150 feet in the southern part of the area to more than 500 feet in the northern portion. Oil shows in the Lodgepole formation have been logged in the northwestern portion of the area.

TABLE 3

Summary of Engineering Data and Reservoir Characteristics

Field: Buffalo	**State:** South Dakota
Operator: Shell Oil Co., Inc.	**County:** Harding
Trap	Strat.-structural
Oldest horizon penetrated (depth)	Cambrian—9335′
Method of discovery	Geophysics
Year of discovery	1953
No. of producing wells	Two
Producing zone(s)	Red River, Ordovician
Average depth(s)	8700′
Type of reservoir rock(s)	Secondary dolomite
Reservoir control	Unknown
Estimated closure	Unknown
Total thickness of pay zone	117′ stained
Net pay	13′
Porosity	Est. 5%
Connate water	Est. 20%
Gravity of oil	33° API
Reservoir volume factor	Est. 1.20
Initial bottom hole pressure	3072 psi—DST ¾ hr.
Est. recovery factor	20%
Producing acreage	Est. 320 acres
Proven undrilled acreage	Undetermined
Cumulative production to 4-1-56	72,220 bbls.
Estimated ultimate recovery	51 bbls./acre foot
Est. ultimate recovery per acre	700 bbls.
Spacing, acres per well	160
Est. ultimate recovery per well	112,000 bbls.

ORDOVICIAN

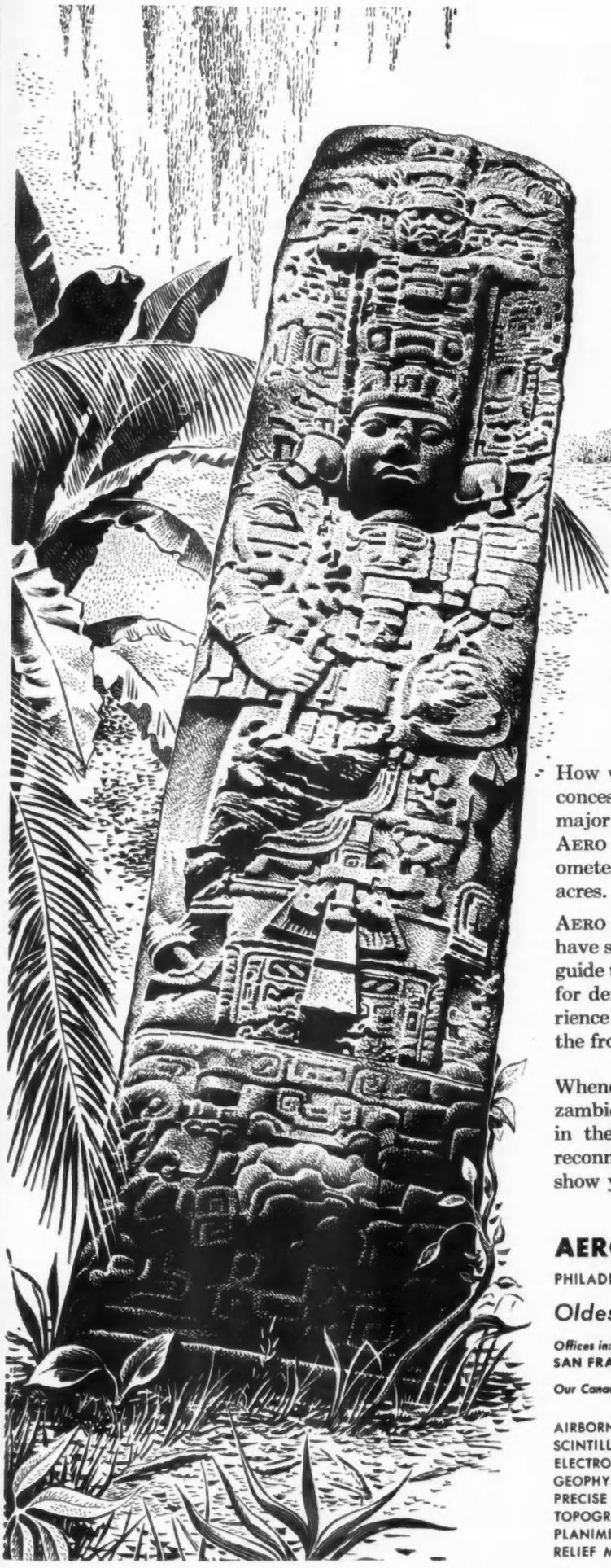
Red River Formation. The Red River formation is made up of interbedded brown, grayish brown, cream and tan, dense to granular and porous dolomites, and cream-to-tan and brown, cryptocrystalline, argillaceous and sub-chalky limestones.

The thickness, distribution and lithology of the Red River formation is shown on Figure 4. The Red River ranges in thickness from approximately 150 feet in the southern part to more than 550 feet in the northern portion of the area. There are several distinct axes of thinning which correspond to the structural axes (compare Figures 2 and 4). The amount of dolomite has been compared to the amount of limestone (dolomite ratio) and the amount of porous dolomite (porosity ratio). By viewing the areas of known oil occurrence and relating these to rock types it can be readily seen that the most favorable bands for Red River production occur where the dolomite ratio and the porosity ratio approach unity or within the belt where the dolomite ratios range from 0.5 to 1 and the porosity ratios from 0.5 to 2.

Winnipeg Formation. The Winnipeg formation is composed of white-to-gray, friable, medium-grained, rounded and frosted sandstone with gray-green shale partings, gray and gray-green soft, bentonitic and fissile shale, with sparsely interbedded cream and gray, cryptocrystalline to argillaceous limestone at the top. The Winnipeg formation ranges in thickness from about 50 to 225 feet in this region and disappears entirely to the south and to the west. A show of oil in the Winnipeg formation was reported in one well in northwestern South Dakota.

POTENTIAL PRODUCING ZONES

There are fifteen potential producing zones in the southwestern flank of the Williston Basin. These fifteen zones may be broken down into primary and secondary objectives. The primary objectives include those zones



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WAYNE E. SWEARINGEN, vice president and chief engineer, Alex W. McCoy Associates, Inc., Tulsa, was graduated from the University of Oklahoma following study in petroleum engineering. He has been active in consultant work as an appraiser of oil and gas properties for primary and secondary recovery. Swearingen is on the executive committee, Mid-Continent section, American Institute of Mechanical Engineers.

in which oil shows have been encountered. Oil shows have not been logged in most of the secondary objectives, but their lithologic aspects suggest that they are potential reservoir rocks.

At the present time the following zones (in ascending order) are considered to be primary objectives: Winnipeg formation, Red River formation, Lodgepole formation, Mission Canyon formation, Charles formation, Minnelusa formation and Newcastle sandstone. The secondary objectives are: Deadwood formation, Silurian system, Devonian system, Big Snowy group, Minnekata formation, Sundance formation, Morrison formation, and Dakota group.

To date there have been two discoveries in the region—the first by the Shell Oil Company at their two-well Buffalo field in T. 21 N., R. 4 E., Harding County, South Dakota, the second by the Ohio Oil Company, Texas Pacific well in T. 1 S., R. 62 E., of Carter County, Montana. Both of these fields produce oil from the Red River formation. A summary of engineering data and reservoir characteristics of these fields is shown on Tables 3 and 4. —**The End**

TABLE 4
Summary of Engineering Data and Reservoir Characteristics

Field: Repeat **Operator:** The Ohio Oil Company	**State:** Montana **County:** Carter
Trap	Strat.—structural
Oldest horizon penetrated (depth)	Cambrian—9358′
Method of discovery	Geophysics
Year of discovery	1956
No. of producing wells	One
Producing zone(s)	Red River, Ordovician
Average depth(s)	8600′
Type of reservoir rock(s)	Secondary dolomite
Reservoir control	Unknown
Estimated closure	Unknown
Total thickness of pay zone	70′ stained
Net pay	15′
Porosity	Est. 5%
Connate water	Est. 30%
Gravity of oil	23.2° API
Reservoir volume factor	Est. 1.15
Initial bottom hole pressure	3625 psi—DST 1 hr.
Est. recovery factor	Est. 20%
Producing acreage	Est. 160 acres
Proven undrilled acreage	Undetermined
Cumulative production	(Not available—new field)
Estimated ultimate recovery	47 bbls./acre foot
Est. ultimate recovery per acre	700 bbls.
Spacing, acres per well	160
Est. ultimate recovery per well	112,000 bbls.

Remarks:
Perf: 8594′ (2 shots)
8628′ (2 shots)
8605′—8610′ (3 shots/ft.)
Acidized with 500 gals.
Flowed 169 bbls. oil, 7½ bbls. water/2 hrs.

Looking Inside the Earth

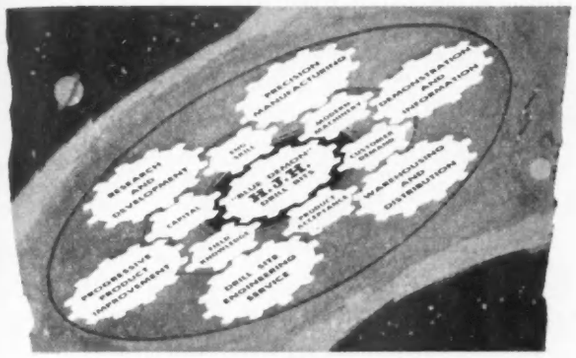
Continued from Page 183

ing of a 24-track record, including the change of record and the punched cards, as required, is about three minutes, and on an average profile an operator may print from 15 to 20 24-track records in an hour.

The automatically recorded series of notches at the upper edge of the profiles in Figures 1 and 2 marks off the span of the tracks of each record. A band of segments across the bottom of the profiles (below the portions shown in Figures 1 and 2) indicates the fixed corrections as actually applied to the tracks.

Versatility in printer operation is provided both in the mechanical construction and in the electrical control circuits, for which relays are the chief control elements. For example, records may be printed with tracks taken in either order; horizontal scale for the printed section may be conveniently chosen, since the profile film is advanced in accurately metered increments, usually from 12 to 24 increments per inch of film; the choice of horizontal scale, together with use of an illuminated slit of appropriate width, allows compaction of the original seismic data with no loss in signal level, a feature often of great value to visual presentation; and through the use of punched cards, the mechanism easily handles the variable corrections for offset shotpoints, broadside shots, and irregularly spaced geophones with no interruption in operating routine.

Farther versatility arises from the provision for automatic compositing of variable-density record tracks. In this process, each record track is printed twice, but in alternate profile-track positions, and corrections are appropriately applied to each of the tracks which contribute to the resulting double exposure. Horizontal scale of the profile may be extended by the automatic printing of each record track twice, thus forming printed tracks in pairs. In addition, the control circuits permit individual record tracks to be skipped or repeated, and blank profile increments to be inserted as desired. Indicator lamps on the main control panel show at all times the progress of the printing and related information. —**The End**



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Formation Evaluation by Log Interpretation

Part 3. Log Interpretation of Oil-Wet Reservoir Rocks of Intergranular Porosity

. . . requires a change in the value of the saturation exponent and recognition of the absence of a mixing zone of mud filtrate invasion.

By **S. J. PIRSON**
Petroleum Engineering Department,
The University of Texas, Austin

WHEN CUTTINGS OR cores of the reservoir rock are available, direct wettability tests may be made to ascertain the preferential wetting characteristics of the minerals for oil and water. A simple technique is the imbibition test, if partially or totally oil-wet, the rock will repel water and if sufficiently finely divided, the individual grains will float on water. If water-wet though containing oil, water will penetrate the rock spontaneously and will displace oil. If relative permeability tests have been made on core samples, the relative permeability to the wetting phase at 50 percent saturation in either phase, is smaller than for the non-wetting phase.

Recognition of the wetting properties of a reservoir rock when no formation sample is available is more difficult since one must rely altogether on characteristics of the log such as the following:

1. In a truly 100 percent oil-wet rock there cannot be any transition zone of saturation from water to oil since water cannot be held up by capillary suction. However, 100 percent oil-wetness is an unlikely probability as the true formation resistivity should in this eventuality be infinite; no such case is on record.

2. Water saturations determined by the various approaches reviewed in Section I of this series of articles do not check one another within reasonable limits of accuracy. The water saturations obtained by Archie's formula using an exponent $n = 2$ are invariably too small and much smaller than obtained by cores, and by the Tixier (RM) method which is still valid in oil-wet sands because it is independent of formation factor and of saturation exponent value though it is necessary to modify the technique and make the mixing factor $z = 0$. The last requirement stems from the lack of a mixing zone in an oil-wet sand between the zone of mud filtrate invasion and the undisturbed reservoir. As the filtrate advances, it fully displaces whatever connate water there is and forms a narrow band of salinity transition between the invaded zone and the undisturbed zone.

3. Porosities determined by the usual methods do not check one another. When using microtools for its calculation, values of formation factors obtained by the methods reviewed in Section I are invariably smaller than actual. The same observation is made when using the short normal curve to calculate porosity.

4. Whenever a resistivity gradient appears in an oil-wet sand, the gradient results generally from a variation in rock-wettability versus height. The computations of permeability from such a gradient invariably yield results that are too high.

5. Whether the reservoir rock is shaly or not, however, an oil-wet rock gives an SP deflection which is in accord with the theory of the electrochemical potential in wells.

The existence of partially oil-wet reservoir rocks is unquestionable though at this writing no reservoir rock totally oil-wet has been reported. The Athabaska tar sand of Canada which is made up of sand grains totally coated with tar, may, however, come close to being fully oil-wet. A totally oil-wet sand should be recognizable on an electric log; when its resistivity is corrected for bore hole effects and invasion, it should be infinite provided the connate water has attained the irreducible insular saturation. Partially oil-wet sands are the Wilcox sand at Oklahoma City, the Springer sand at Sholem-Alechem, Oklahoma, the Tensleep sand at Little Buffalo Basin and Elk Basin, Wyoming, and many Permian Basin limestones and dolomites.

It is obvious from the above discussion that the interpretation of logs in oil-wet sands requires modifications to the general theory; these being an appropriate change in the value of the saturation exponent and the recognition of the absence of a mixing zone of mud filtrate invasion.

Some early experiments of Morse et al (1947) already indicated that the saturation exponent in the Archie equation should assume higher values than 2.0 in oil-wet rocks. However, Keller[6] in 1953 presented a systematic investigation of the effect of varying degrees of wettability on the electrical resistivity of sands and showed that as the relative wettability increases the value of the satura-

ERRATA

The following correction should be made in Part 1 of this series, April, 1957, WORLD OIL.

Page 164: Second column, thirty-first line, change **and** to **are.**

Page 166: Formula 12 should read—$\mu = \frac{\upsilon \text{ centistokes}}{1/\delta_o}$

Page 168: First column, lines 9, 11 and 32, change 3063 to 3074.

Since publication of the first installment of this series, Schlumberger Well Surveying Corp. has issued new Chart C-18 for its "Log Interpretation Charts" handbook. This chart should replace Figure 3 of this series.

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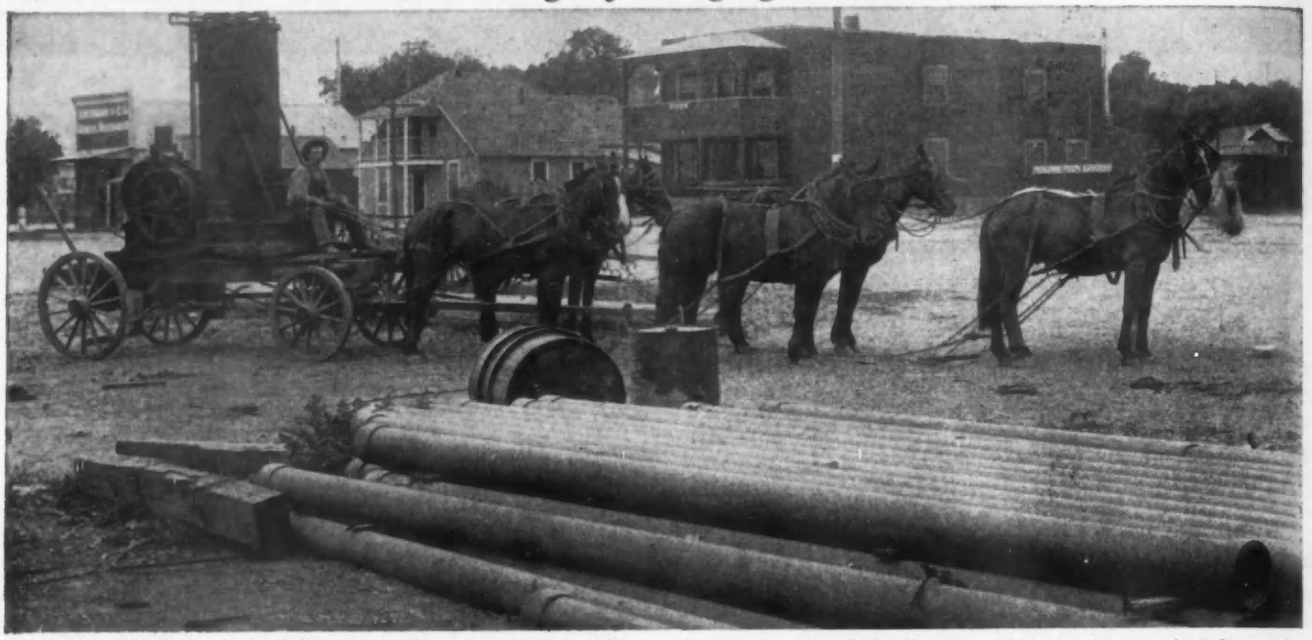

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tion exponent takes on values larger than 2.0 and may approach 10 for completely oil-wet sands.

In an oil-wet rock the relative positions of the water and of the oil phases are inverted over their position when water-wet. As a result of this, various modifications to a comprehensive log interpretation program are needed:

First of all, under invasion by the aqueous phases of the drilling mud, the connate water is collected at the head of the invasion front and is fully displaced by it. The invaded zone, when sufficiently deep, may be considered as equivalent to the flushed zone and contains mud filtrate of resistivity R_{mf}. In an oil-wet sand there will always be a residual oil saturation S_{or}. In order to determine the expected productivity from an oil-wet rock, the relative permeability formulae must also be inverted. The movable oil saturation corresponds to the movable water of water-wet rocks. Since the oil phase is not conducting electricity, it is necessary to substitute appropriate oil saturation values in the relative permeability formulae.

The following modified equations are, therefore, in order when interpreting oil-wet sands:

$$S_{we} = \sqrt[n]{\frac{R_o}{R_t}} \quad \text{where } n > 2;\ n = 2.2 \ldots 3 \ldots 4 \ldots \tag{36}$$

$$F = S_{xo}^{\,n}\,(R_{xo}/R_{mf}) \quad \text{when determining porosity from microtools} \tag{37}$$

$$F = S_{xi}^{\,n}\,(R_i/R_{mf}) \quad \text{with } z = 0 \text{ when determining porosity from the short normal curve.} \tag{38}$$

S_{xo} and S_{xi} should be substantially equal; in fact, they should each be equal to 1 — ROS because in an oil-wet sand the residual oil saturation should be substantially the same in the flushed zone and in the invaded zone. Hence, R_{xo} and R_i in an oil-wet sand should be the same. If they are different, it is because the distance of invasion may be too short for the short normal to read only within it. Differences in R_{xo} and R_i may also result from the effect of the salt water band displaced ahead of the invasion front.

The Tixier (RM) method must be modified as follows:

It is postulated that the mud filtrate saturation S_{xi} in the invaded zone is such that

$$S_{xi} = \sqrt[n]{S_{we}} \tag{39}$$

where n is the same saturation exponent as used in Archie's formula for oil-wet sands. The following relations also apply:

$$S_{xi} = \sqrt[n]{\frac{F\,R_{mf}}{R_i}} \tag{40}$$

$$S_{we} = \sqrt[n]{\frac{F\,R_{we}}{R_t}} \tag{41}$$

Combining the three equations, the following is obtained:

$$S_{we} = \left(\frac{R_i}{R_t}\right)^{\frac{1}{n-1}} \left(\frac{R_{we}}{R_{mf}}\right)^{\frac{1}{n-1}} \tag{42}$$

By juggling the various equations reported here, it is possible to establish a reasonable value for the saturation exponent n.

In partially oil-wet rocks and for simultaneous flow of oil and water, equations 7, 8 and 9 become

$$K_o = S_{om}^{1/2}\,S_o^{1/2} \tag{43}$$

$$k_w = \left(1 - \frac{S_o - S_{oi}}{1 - S_{oi} - S_{nwt}}\right)^2 \quad \text{imbib.} \tag{44}$$

$$k_w = (1 - S_{om})\,[1 - S_{om}^{1/4}\,S_o^{1/2}]^2 \quad \text{drain.} \tag{45}$$

in which

S_o is the total oil saturation obtained by difference = 1 — S_{we}, S_{we} being computed by (36).

S_{om} is the free or movable oil saturation obtained by $\frac{S_o - S_{oi}}{1 - S_{oi}}$

S_{oi} is the irreducible oil saturation and is the equivalent of S_{wi} for a clean water-wet rock. Knowing porosity and permeability, S_{oi} is determined by Figure 5.

S_{nwt} is the trapped non-wetting (water) saturation which is determinable from pore size distribution considerations.

The connate water saturation, S_{we}, in an oil-wet sand is obtained by Archie's formula when the appropriate value of n as saturation exponent is used. This value depends on the degree of oil wettability of the rock.

The value of the saturation exponent n to be used in Archie's formula is considerably in doubt. Keller has shown that under increasing degree of wettability of reservoir rock, the value of n required should be slightly larger than 2.0 for slightly oil-wet sands and may be as high as 10 for totally oil-wet sands. Tentatively, experience has shown that the Springer sand seems to require an exponent n = 3.0 and the Tensleep sand n = 4.0.

Techniques for recognition of oil-wettability and the degree thereof are in their infancy. From electric logs, except for totally oil-wet rock in capillary equilibrium, means of recognizing oil wettability are of a circumstantial nature; when the various approaches whereby porosity and water saturation are obtained do not satisfactorily check one another, oil wettability may often be suspected and the value of n to be used is that one which gives such a check.

From formation samples and cores, simple imbibition tests for water and oil are satisfactory to ascertain wettability provided the samples of rock, water and oil have not been exposed to air. A nuclear resonance test was recently advocated (Brown and Fatt, 1956) whereby the degree of oil wettability may be determined from formation samples provided the intermediate degree of wettability may be ascribed to a mixture of totally oil-wet and totally water-wet grains.

Examples of Log Interpretation in Oil-Wet Rocks

EXAMPLE V

The log of Figure 18 is from the Springer section in Southern Oklahoma. Its characteristics are those of an oil-wet sand as evidenced by the following considerations:

By standard procedure the microlog computes a porosity of 21 percent and F = 19. Similar calculations from the short normal curve yield unreasonably small porosity (11.8 percent), and it is concluded that the short normal reading is affected by R_t, and in this instance it reads too high. However, using the Tixier (RM) method modified as suggested above and with a saturation exponent n = 3, one finds F = 20 and ϕ = 20. Hence, it is believed that the exponent n = 3 is satisfactory for this sand. Water saturation with n = 3 is 23 percent. By the tortuosity-permeability correlation (Figure 4), permeability is 100 md. The irreducible oil saturation by Figure 5 is 20 percent.

Movable oil saturation $= \frac{.79 - .20}{1 - .20} = 74$ percent. The trapped water saturation is evaluated at 15 percent leaving a movable water of 8 percent pore space. Computing the relative permeability characteristics:

$k_o = 0.53$

$k_w = 0.004$

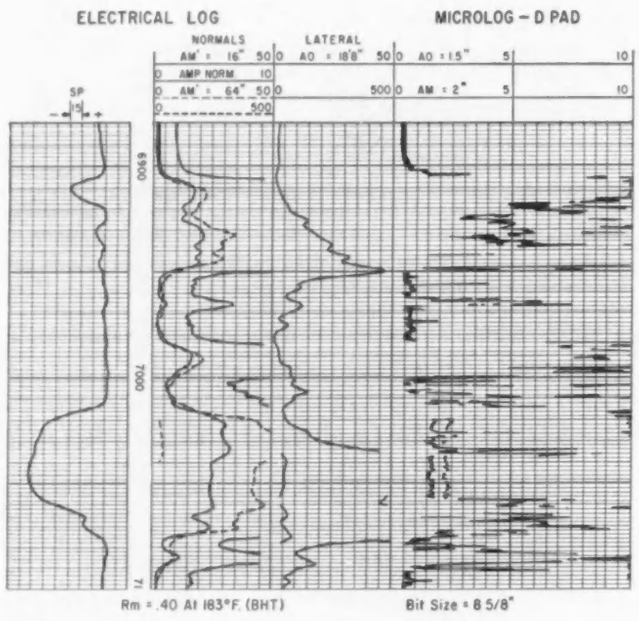

FIGURE 18—Electric log of the Springer Sand Section of a well in Southern Oklahoma that exhibits oil-wet sand characteristics.

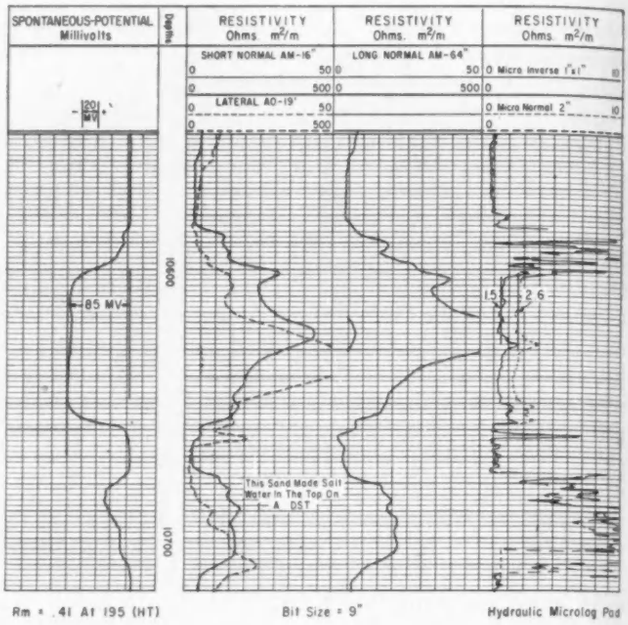

FIGURE 19—Another log of the Springer Sand Section exhibiting oil-wet sand characteristics. However, the water-oil ratio computes to be 37.5 to 1 and the well was later plugged and abandoned.

Hence, a negligible water-oil ratio will exist. Indeed, the well is an oil producer.

EXAMPLE VI

The log of Figure 19 is also from the Springer sand section in Southern Oklahoma. Its characteristics are also that of an oil-wet sand and the interpretation gives the following results:

The porosity from the microlog computes to be 9.5 percent whereas from the short normal it is found to be 9 percent (using a saturation exponent of 3). The modified Tixier (RM) method gives a water saturation of 38 percent and a porosity of 7.5 percent.

Permeability determination by the tortuosity correlation gives by extrapolation 0.1 md. The irreducible wetting phase (oil) is, therefore, 55 percent. Movable oil saturation is, therefore, only 7 percent of pore space.

Calculations of relative permeability give:

$$k_o = 0.052$$
$$k_w = 0.75$$

Estimate of reservoir fluid properties are:

$$\beta = 1.58$$
$$\mu_o = 0.5 \text{ cps}$$
$$\mu_w = 0.3 \text{ cps}$$

Water-oil ratio computes 37.5 to 1. In fact, the well on test showed 4500 feet of water and was plugged and abandoned.

Part 4. Log Interpretation in Rocks With Multiple Porosity Types; Water or Oil-Wet

Interpretations of a multiple porosity rock can be simplified by considering the respective percentages of each porosity system.

VISUAL RECOGNITION from core samples that a reservoir rock exhibits multiple porosity types is the most positive means of establishing the nature of this problem. In the absence of core, recognition of this type of reservoir from logs is not an easy matter and it is even more difficult to determine the void space breakdown between the various porosity types. An attempt may be made by comparison of microtool porosity (ϕ_{mt}) with macrotool porosity (ϕ_{Mt}) the latter being obtained from the short normal curve, limestone curve, neutron curve, etc. Microtools, in fact, respond to intergranular porosity and may even indicate the frequency of occurance of fractures and vugs under ideal conditions. Macrotools, on the other hand, because of their larger radius of investigation, respond to total porosity. Vug and fracture porosity may then be obtained by difference $= \phi_{Mt} - \phi_{mt}$.

Rocks with multiple porosity systems are those which do not have a uniform pore texture but exhibit various systems of porosity in parallel, the pores or opening sizes of which are widely different in magnitude. Such is the case for:

(a) **Fractured rocks:** these may either be limestones (such as the Ellenburger, Arbuckle, Hunton, Annona Chalk, Austin Chalk etc.), sandstones (such as in the Spraberry field etc.), shales (Florence field, Colorado, and Roosevelt field, Utah), basement schist, (California).

(b) **Vuggy rocks** as generally encountered in dolomites, weathered limestones etc.

(c) **Oolitic rocks** where porosity exists inside the oolites, such as in the Grayburg formation of the Permian Basin.

The complexity of such systems may perhaps be simplified by considering that there are only two porosity systems in parallel and that the respective proportions of each may be evaluated by such procedure as large core analysis, and especially by porosity testing by the Locke and Bliss (1950) method. Let v represent the fraction of total porosity made up of vugs, fractures and the like. (v) represents, in effect, the fraction of total porosity through which a path of least resistance to fluid flow exists; especially by injection.

In the undisturbed state, in situ, various fluid saturation conditions may be postulated:

(a) Reservoir rock at 100 percent formation water saturation. If the resistivity (R_{fo}) of such a rock is measured, the following relation exists:

$$\frac{1}{R_{fo}} = \frac{v\phi}{R_{wc}} + \frac{1-v}{R_o} \qquad (46)$$

by the application of the formula for conductivity systems in parallel. R_o is the resistivity of the blocks of intergranular porosity, and the value of which is given by the usual formula $R_o = FR_{wc}$.

The formation factor of the blocks (F) may be obtained in the laboratory from homogeneous formation samples or in the well bore from micrologging tools.

(b) Reservoir rock at partial formation water saturation in the blocks but 100 percent formation water saturation in the vugs and fractures. If the resistivity (R_{ft}) of such a rock is measured, the following relation obtains:

$$\frac{1}{R_{ft}} = \frac{v\phi}{R_{wc}} + \frac{1-v}{R_t} \qquad (47)$$

where R_t is the resistivity of the blocks and may be expressed by Archie's formula:

$$R_t = F\,R_{wc}\,(S_{wc})^{-n}$$

The true resistivity of the blocks may be determined indirectly and the possible productivity from the blocks may thus be ascertained. This represents the condition that would likely prevail in an oil-wet rock for the non-wetting phase (water) would tend to occupy the largest pore spaces.

(c) Reservoir rock at partial formation water saturation both in the fractures and in the blocks.

If the resistivity (R_{ft}) of such a rock is measured, the following relation obtains:

$$\frac{1}{R_{ft}} = \frac{v\phi\,S_{fw}}{R_{wc}} + \frac{1-v}{R_t} \qquad (48)$$

where S_{fw} is the formation water saturation in the fractures and vugs. In such a system of fracture and vugs, it is expected that the bulk electric conductivity is directly proportional to saturation in conductive fluid.

(d) Reservoir blocks at 100 percent connate water saturation and fracture-vug system at partial water saturation.

The blocks' resistivity is $R_o = FR_{wc}$.

The resistivity of the whole system is:

$$\frac{1}{R_{ft}} = \frac{v\phi\,S_{fw}}{R_{wc}} + \frac{1-v}{R_o} = \frac{1}{R_{wc}}\left[v\phi\,S_{fw} + \frac{1-v}{F}\right] \qquad (49)$$

This represents the conditions that would likely prevail in a water-wet formation, for the non-wetting phase (oil and gas) tends to occupy in it the largest pore spaces (vugs and fractures), whereas water would occupy the fine capillaries in the blocks.

The relative permeabilities that would prevail during production from such a reservoir are directly proportional to fluid saturation in the vug and fracture system because production of water from the block system is not likely to occur.

During drilling operations, fractured and vuggy rocks are subjected to infiltration by mud filtrate of resistivity (R_{mf}). The latter preferentially finds its way in the fractures and vugs and little, if any, fluid is displaced from the blocks unless it be by capillary imbibition.

In a water-bearing fractured rock, the following relation holds in the invaded zone for its resistivity (R_{fi}):

$$\frac{1}{R_{fi}} = \frac{v\phi}{R_{mf}} + \frac{1-v}{R_o} \qquad (50)$$

In an oil-bearing fractured rock, the following holds for the invaded zone:

$$\frac{1}{R_{fi}} = \frac{v\phi}{R_{mf}} + \frac{1-v}{R_t} \qquad (51)$$

It is expected that complete displacement of formation water from the fracture-vug system takes place regardless of the original saturation.

By solving the invaded zone equations, it may be ascertained whether or not the blocks contain oil or gas. The equations for the non-invaded section provides a verification of the interpretation. The expected productivity from fractured reservoir rocks may be ascertained by the application of the relative permeability formulae 7, 8 and 9 previously stated as applied to the block system. However, the water-oil ratio will be controlled mostly by the saturation conditions existing in the fracture system and by the proximity to the water-oil contact.

In a fractured or vuggy system, the relative permeability to each phase in the system is directly proportional to the saturation in that phase such that:

$$K_{fo} = KS_{fo}$$
$$K_{fw} = KS_{fw} \qquad (52)$$
$$K_{fg} = KS_{fg}$$

where the subscript (f) refers to the fracture system.

Example of Log Interpretation in Fractured Rocks
EXAMPLE VII

The example log of Figure 20 is from the Pine Island field, Caddo Parish, Louisiana, and production is obtained from the Annona chalk of Cretaceous age. Inasmuch as the quality of the logs obtained in this formation leaves much to be desired, it is necessary to depend to a certain extent on some rock and reservoir fluid properties that are known from core analysis and production data:

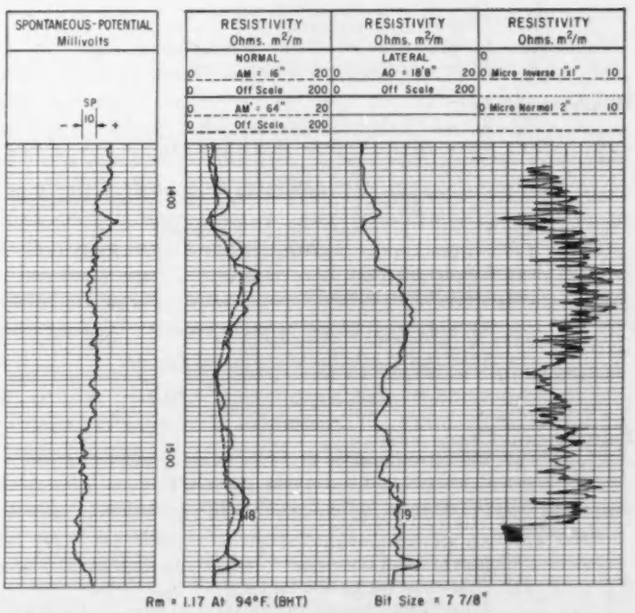

FIGURE 20—A log from the Annona Chalk of Cretaceous age from a well in the Pine Island field of Caddo Parish, La. The quality of the log is poor and core analysis and production data must be used to a great extent.

Average permeability: nil to 1.5 md
Average porosity: 25 to 28 percent
Total water saturation: 30 to 60 percent, may produce clean oil when as high as 75 percent
Oil gravity: 34 degrees API
Water salinity: 27,000 ppm

It is postulated from the log that the fraction of fracture and intergranular porosity is respectively about 10 and 90 percent. ($v = 0.10$). The blocks are considered to have 25 percent pore space ($F = 12.5$) and the fracture system represents 2.5 percent pore space or a total of 27.5 percent. The reservoir rock is assumed to be water-wet and to contain both oil and water phases in the fractures and blocks alike. This is justified by the known observation that water will imbibe the rock.

From the short normal reading of 8 ohm-meter at 1520 feet in depth and by application of equation 47, one finds $R_t = 11$ ohm-meter. From the lateral reading of 9 ohm-meter at the same depth and by application of equation 48, one finds $S_{fw} = 0.19$. Since the fracture system controls the fluid production at the wells, the relative permeabilities to water and oil are respectively, in the fracture system, according to equation 52:

$$k_{fw} = 0.19$$

$$k_{fo} = 0.81$$

Oil viscosity in place is estimated at 5 cps and water viscosity is 0.7 cps. Reservoir volume factor is estimated at 1.05 in view of the shallow depth and sub-normal field pressure. The water-oil ratio accordingly calculates to be 1.6. This is in agreement with actual production ratios, a water-oil ratio value being reported to be 1.7 in a slanted drain hole well after fracturing.[7] Actual production results from the well studied here are not known. Water saturation in the blocks is calculated to be 41.5 percent.

NOMENCLATURE

Resistivity (ohm-meter):

R: Resistivity
R_a: Apparent resistivity
R_t: True resistivity
R_{ft}: True resistivity of a fractured rock
R_{tt}: True resistivity at the level of irreducible water saturation
R_{wc}: Connate water resistivity
R_{wa}: Apparent water resistivity computed from a reduced SP deflection
R_m: Mud resistivity
R_{mf}: Mud filtrate resistivity
R_{mc}: Mud cake resistivity
R_o: Resistivity of porous rock at 100% connate water saturation
R_{fo}: Resistivity of fractured rock at 100% connate water saturation
R_{xo}: Flushed zone resistivity
R_i: Invaded zone resistivity
R_{fi}: Invaded zone resistivity in a fractured rock
R_s: Shale or adjacent bed resistivity

SP Characteristics:

ASP: Actual SP deflection (millivolts)
SSP: Static SP deflection, in a clean porous rock of low resistivity (millivolts)
PSP: Pseudostatic SP deflection in a shaly water sand (millivolts)
t_f: Formation temperature, ° Farenheit
T_f: Formation temperature $= 460 + t_f$: ° Rankine
log: Logarithm base 10
l_n: Logarithm base e
α: SP reduction factor in shaly sand $= \frac{PSP}{SSP}$
b: Shell shalyness characterization number
k: SP lithological factor $= \frac{T_f}{538} \times 70.7$

Petrophysical Characteristics:

ϕ: Effective porosity
ϕ_t: Total porosity (also true porosity)
ϕh: Hydration occupied pore space
ϕ_{mt}: Microtool porosity
ϕ_{Mt}: Macrotool porosity
F: Formation factor
F_a: Apparent formation factor
$F_{0.01}$: Formation factor measured at $R_{wc} = 0.01$ and 78° F.
F_t: True formation factor or that measured at 100% formation water saturation
S_{wc}: Connate water saturation
S_{wi}: Irreducible water saturation
S_{wm}: Movable water saturation
S_{om}: Movable oil saturation
S_{fw}: Water saturation in a fracture or vug system
S_{fo}: Oil saturation in a fracture or vug system
S_{fg}: Gas saturation in a fracture or vug system
S_{xo}: Water saturation in flushed zone
S_{xi}: Water saturation in invaded zone
S_{nwt}: Trapped non-wetting phase saturation
K: Specific permeability; (darcy)
K_o, K_w, K_g: Effective permeability to oil, water, gas (darcy)
k_o, k_w, k_g: Relative permeability to oil, water, gas
k_w: Wetting phase relative permeability
k_{nw}: Non-wetting phase relative permeability
k_{nw}(drai): Non-wetting phase relative permeability (drainage)
k_{nw} (imb): Non-wetting phase relative permeability (imbibition)
v: Fraction of pore space represented by vugs and fractures
n: Saturation exponent in Archie's equation

Fluid Properties:

α: Reservoir volume factor for gas: dimensionless
β: Reservoir volume factor for oil: dimensionless
S: Solution gas; vol./vol.: dimensionless
μ_o, μ_w, μ_g: Reservoir viscosities for oil, water, gas (centipoise)
ν: Kinematic viscosity (centistoke)

Length:

h: Gross pay (feet)
h_e: Effective pay (feet)
d: Hole diameter (inches)
e_{mc}: Mud cake thickness (inch)
r: Radial distance (feet)
r_w: Well radius (feet)
r_e: Drainage radius (feet)
D_i: Diameter of invaded zone (hole diameter)

Engineering Characteristics:

P: Pressure (psia)
P_o: Original pressure (psia)
P_b: Bubble-point pressure (psia)
Q_o: Open flow potential bbl./Day STO
Q_g: Open flow potential: CF_t/Day
ΔP: Differential pressure (drawdown) (psia)
WOR: Water-oil ratio: dimensionless
WGR: Water-gas ratio: dimensionless
ER: Oil recovery by expansion per acre × foot (bbl.)
DR: Oil recovery by depletion drive per acre × foot (bbl.)
WR: Oil recovery by water drive per acre × foot (bbl.)
SR: Oil recovery by segregation drive per acre × foot (bbl.)
CR: Oil recovery by combination drive per acre × foot (bbl.)

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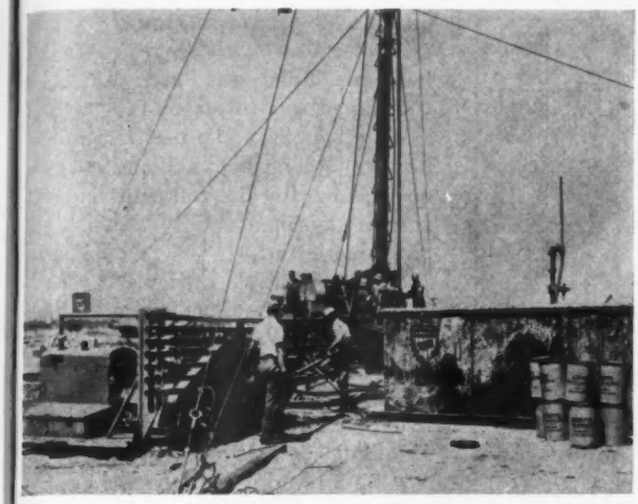
—**The End.**



FIGURES 1 and 2—Mixing fluid loss additive to crude oil used in reverse circulation operations so as to prevent loss of oil to the formation. The additive is added to the oil in the mud pits, mixed with the mud guns and pumped down the well.

Fluid Loss Additive Aids Workover Efficiency

In low formation pressure areas workovers with circulation systems were not economical due to high fluid loss. Now, additives can make this an economically successful operation.

By J. G. DAVIS, ROBERT T. MEANS and PAUL W. WHITAKER
Continental Oil Company
Ponca City, Okla.

REVERSE CIRCULATION equipment has been effective in reducing the cost of well clean out operations in many areas. The cost reduction results primarily from the speed with which shale and other extraneous material may be reversed from a well.

The continuous operation of a bit and fluid circulating system is in contrast with the time-consuming trips with the bailer or sand pump of a cable tool rig. Clean out work is made easier on deep holes and the well is under control at all times. In addition, the basic machinery such as rotary table, mud pump and prime mover often may be rented for use with company-owned pulling units.

Clean out work of this type is hampered, however, in some fields by excessive loss of fluid to the formation. This has been particularly true when crude oil has been tried as the circulating fluid in certain areas in West Texas and in the Rocky Mountains. Excessive loss of fluid increases the cost of the workover by requiring longer rig time to clean out, longer swabbing time to recover the load oil and additional hauling costs. Sometimes when circulation cannot be maintained, the operator is forced to revert to cable tools.

Crude as a Circulating Fluid. Many operators who utilize reverse circulation equipment have found crude oil to be more efficient than mud or salt water as a circulating fluid. The preference is usually based on data that show the oil to be more economical to use than mud and more effective in preventing damage to the producing zone than salt water. The inability to employ crude oil because of high fluid losses is, therefore, a very real and important problem.

An example of difficulties in West Texas may be seen by examining the average conditions existing in one field. Wells in this particular area are completed open hole at depths of approximately 4500 feet. Normal workover operations involve the cleaning out of about 100 feet of the open hole section. The holes can be loaded with crude but the formation will take oil with ease when surface pressures of 45 or 50 psi are applied. This greatly reduces the rate with which the cuttings can be returned to the surface.

In addition, only about 50 percent circulation can be established. Oil losses on the average job will, consequently, run in the neighborhood of 400 barrels. Reversing operations may be abandoned when the loss reaches 600 or 700 barrels. A few attempts to push on through have resulted in losses as high as 1200 barrels. These results, although averages for a specific area, are typical of many fields.

Fluid Loss Additive. The situation in West Texas was relieved by one contractor who adapted a recently developed fluid loss additive for oil well fracturing fluids to reverse clean out operations. This material, is added to the oil in the mud pits, mixed with the mud guns, and pumped down the well. The simplicity of the arrangement may be seen in Figures 1 and 2 which show a typical reverse circulation unit and the method of mixing the fluid loss additive on location.

Figure 3 illustrates how the fluid

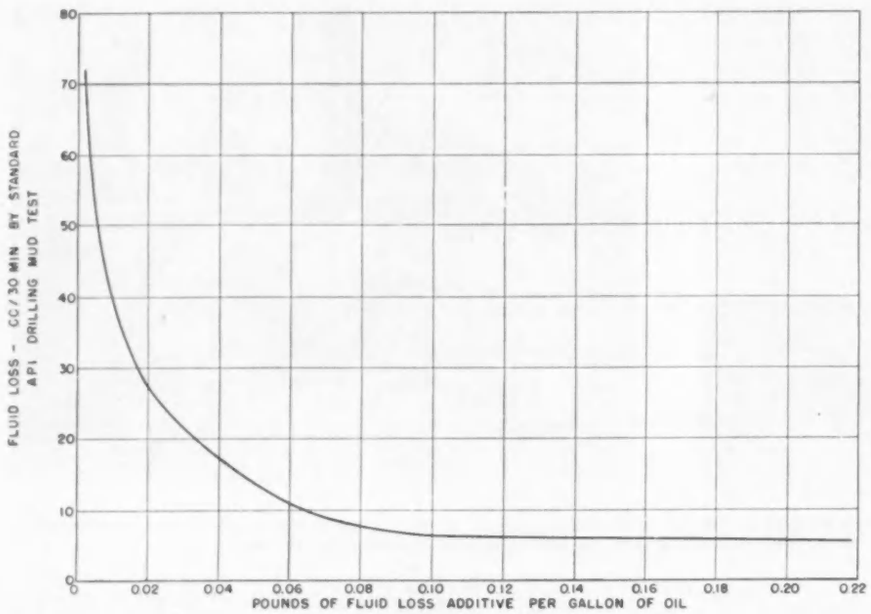


FIGURE 3—Fluid loss of Rocky Mountain crude oil with different amounts of fluid loss additive.

loss of a crude oil is lowered by the fluid loss additive when tested in the conventional manner used for drilling muds. The untreated crude passed through the test apparatus at a rate of approximately 100 cc in one minute. Only a small amount of additive was needed to reduce this loss to about 25 cc in 30 minutes. The normally recommended concentration of 0.1 pound of additive per gallon of oil reduced the loss still further to 6 cc in 30 minutes. Usually the loss of fluid will be completely stopped at the end of 30 minutes. Comparable losses may be expected in actual down hole operations as the additive maintains the seal in the presence of turbulence caused by the bit and circulating fluid.

Results in the area previously mentioned were significantly better when the pre-treated crude was used. Surface pressures of 200 or 300 psi could be applied without appreciable loss of oil and circulation approached 100 percent. Total losses varied from 20 to 250 barrels.

Natural Fractures. In some instances natural fractures were present in the formation and even the treated crude could not be circulated without a substantial loss of oil. This problem was solved by the incorporation of a small amount of an oil soluble resin type lost circulation material with the treated crude oil. The coarser material effectively bridged the fracture openings while the fluid loss agent created the final seal on both the bridging material and the natural formation porosity. Total treating costs proved to be low enough that the lost circulation material was soon included in almost all treatments as a safeguard against fluid loss in abnormally large openings.

The following are a few case histories from West Texas:

Well A—
Job: Clean out 200 feet of hole, a portion of which had been shot with 350 quarts of SNG.
Circulating Oil: 180 barrels of crude oil containing 800 pounds of fluid loss additive and 400 pounds of lost circulation material.
Total Oil Loss: 20 barrels.

Well B—
Job: Clean out 100 feet of open hole.
Circulating Oil: 220 barrels of crude oil containing 1100 pounds of fluid loss additive and 100 pounds of lost circulation material.
Total Oil Loss: 60 barrels.

Well C—
Job: Clean out 100 feet of open hole.
Circulating Oil: 320 barrels of crude oil containing 1200 pounds of fluid loss additive and 600 pounds of lost circulation material.
Total Oil Loss: 160 barrels (Most of the oil was lost in establishing initial circulation.)

Well D—
Job: Clean out 100 feet of open hole.
Circulating Oil: 180 barrels of crude oil containing 800 pounds of fluid loss additive and 400 pounds of lost circulation material.
Total Oil Loss: Less than 20 barrels.

The two materials were also tried in a deep well in another West Texas field where a lost circulation problem had arisen when an attempt was made to drill out a cement retainer located below perforations in the pipe. Total oil loss was restricted to about 200 barrels. This was considered to be successful since prior to the operation, very high oil losses had precluded the use of rotary equipment for workovers in this area.

An example of the use of the fluid loss controlling agent alone in crude oil is shown by the following excerpt from a Continental Oil Company engineering letter:

"Considerable difficulty was encountered in keeping the hole loaded in Wasson 52 No. 7 (West Texas) while the deepening operations were in progress. Approximately 500 barrels of oil were used to kill the well and establish circulation prior to the deepening work. After the deepening work was begun, the hole continued to use a large volume of oil to maintain circulation. In an effort to reduce this excessive fluid loss, 800 pounds of fluid loss additive were added to 200 barrels of oil and this treated oil was used to drill the new hole. After this oil was distributed throughout the system, the fluid loss to the formation was decreased by approximately 80 percent.

"In the future when it is anticipated that considerable amount of circulating time will be required to complete a workover, treated oil will be used initially to kill the well and establish circulation. It is believed that the reduction in hauling costs will offset the cost of the additive and the workovers can be completed with a minimum amount of fluid loss to the formation thereby reducing the swabbing time."

Similar difficulty in establishing circulation and in completing workover operations without high losses of oil have been experienced in the Rocky Mountain Region. Results of the application of treated crude can be seen in the field data that follow.

Field Data. One well in this region was losing 40 barrels of oil an hour during a clean out operation in which a mixture of crude oil and a lost circulation material were used. A fluid loss agent was added and the rate of loss of oil was reduced to 18 barrels per hour.

Another well gives a good comparison of the use of treated and of untreated crude since the same section had to be cleaned out on two separate occasions. The first workover utilized crude oil and a lost circulation material. Approximately

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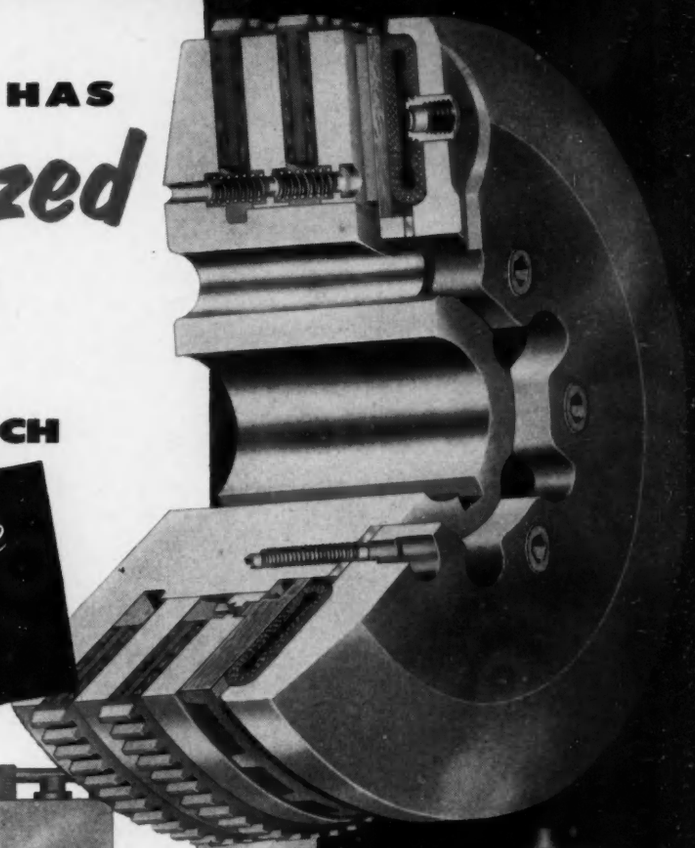

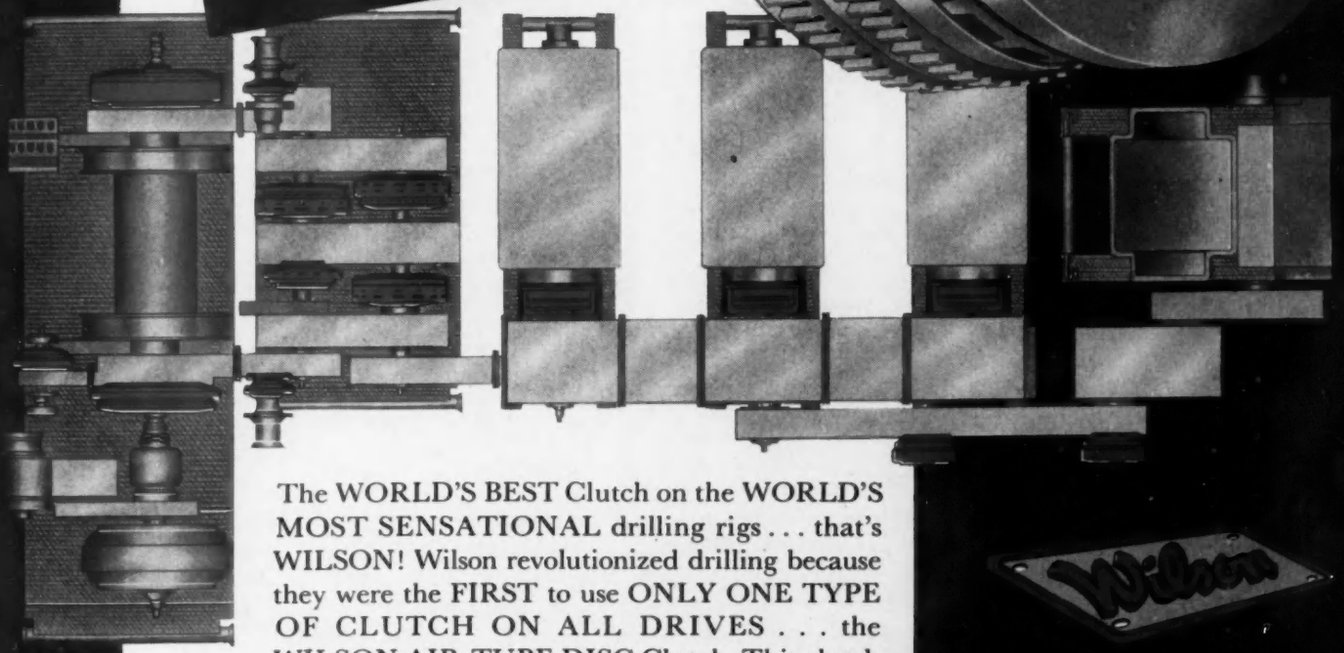

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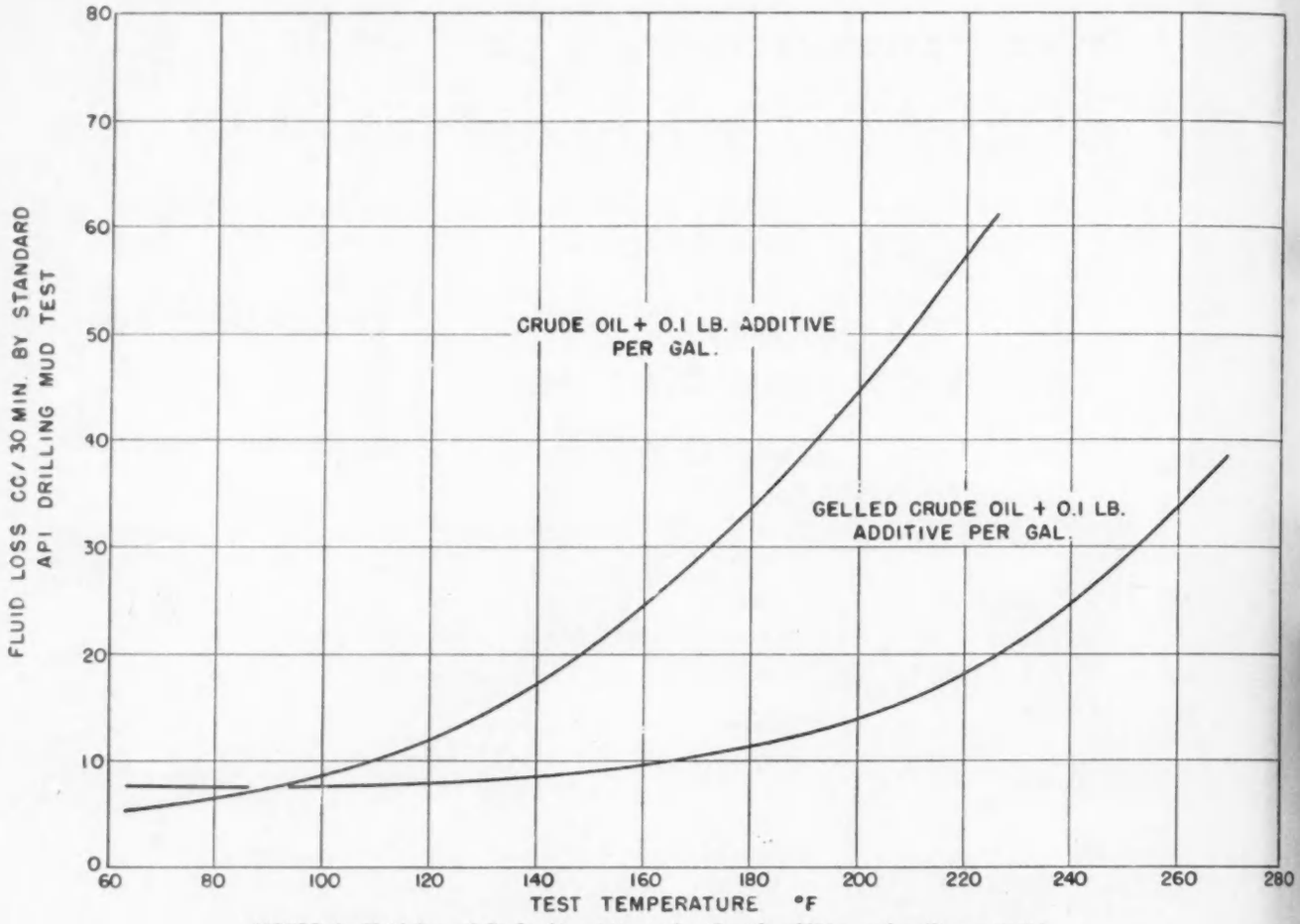

FIGURE 4—Fluid loss of Rocky Mountain crude oil with additive and gelling material.

3500 barrels of crude were lost in cleaning out 400 feet of hole that had been heavily shot with SNG. Addition of the fluid loss agent to the second job reduced the oil loss to 500 barrels for the same 400 feet of section.

Data on this well and eight wells similarly treated in the same field show an average of 50 percent less oil loss when the treated crude was used. Results from other wells in the area indicate that the 50 percent reduction is reasonably consistent.

Occasionally wells have been found that will not respond adequately to either the low fluid loss treatment, lost circulation material or to a combination of both additives. The difficulty in these cases has been overcome by the addition of a gelling material to the treated oil. Gelation of the crude allows the cuttings to be returned at much lower circulating rates, thereby reducing the pump pressure necessary and proportionately lowering the rate of oil loss. The gel material may be effective also in lowering the fluid loss characteristics of the treated crude. The latter effect will be of particular importance when the bottom hole temperatures are high.

Gelled and Ungelled Crude Reaction. Figure 4 shows the fluid loss reaction of both a gelled and ungelled treated Rocky Mountain crude to temperature. The upper curve represents the crude oil treated with 0.1 pound of additive per gallon. Fluid losses became steadily higher at higher temperature, reaching a value of 34 cc in 30 minutes at 180° F. The same treatment was used to obtain the data for the lower curve, but in addition the oil was gelled with a standard commercial gelling material. Control is improved at high temperatures and the fluid loss is restricted to 12 cc at 180° F.

A recent innovation in the Rocky Mountains has given additional justification to the use of the treated oil. Crudes treated with the fluid loss controlling agent and a lost circulation material are used as the circulating fluid in the workover. After the well has been cleaned out to the desired depth, the treated oil is run over a fine shaker screen and the lost circulation material removed. (No screen usable in a drilling mud system will be fine enough to remove the fluid loss controlling agent.) This oil is then gelled and used to fracture the well. Two operations are thereby performed at an appreciable saving over the normal cost of individual jobs. Fracturing treatments as large as 20,000 gallons have been completed in this manner without sand-outs or other difficulty.

The data obtained so far show a definite application of fluid loss control in reverse circulation operations in the specific areas in which this type of treatment has been tried. Success has been so general in these instances, however, as to indicate the distinct possibility of successful application in many other areas.

The ability to control the fluid loss of the circulating fluid may be of additional benefit by making the reverse type clean out operation attractive in areas where the more expensive cable tool method has been favored in the past.

ACKNOWLEDGMENT

The authors wish to thank Wright Rental Tools of Odessa, Texas, and the Sharples Oil Corporation of Denver, Colorado, for portions of the data presented. They also wish to thank the management of the Continental Oil Company for permission to publish this article.

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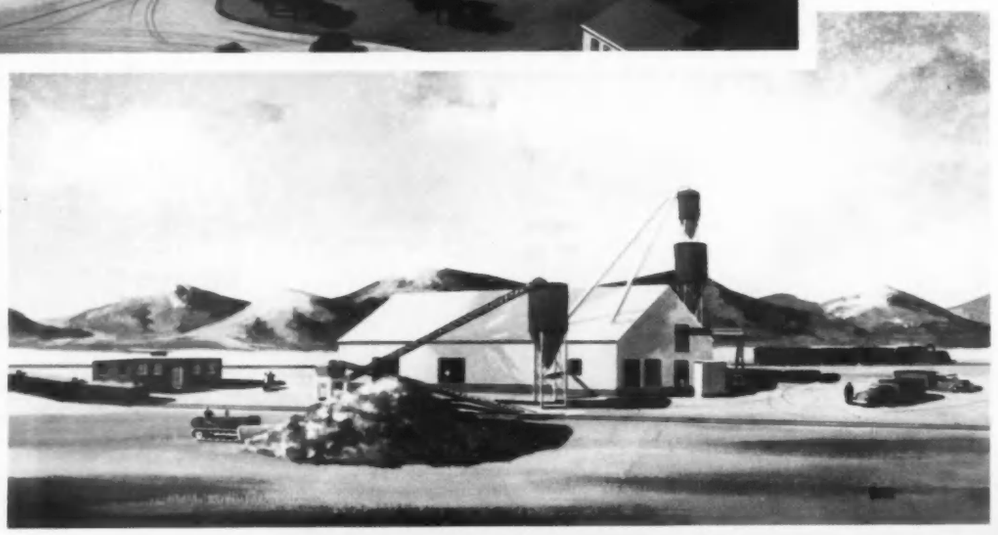

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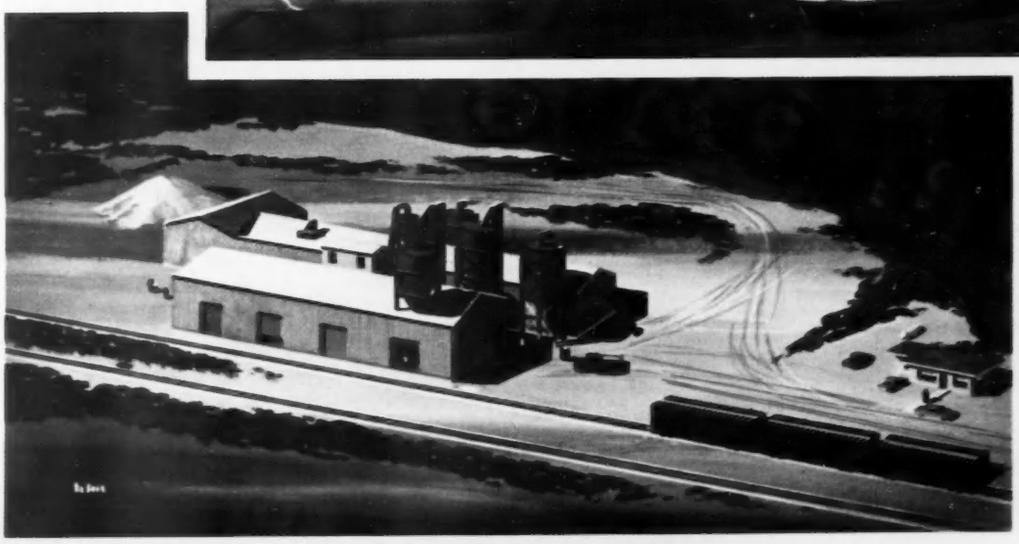

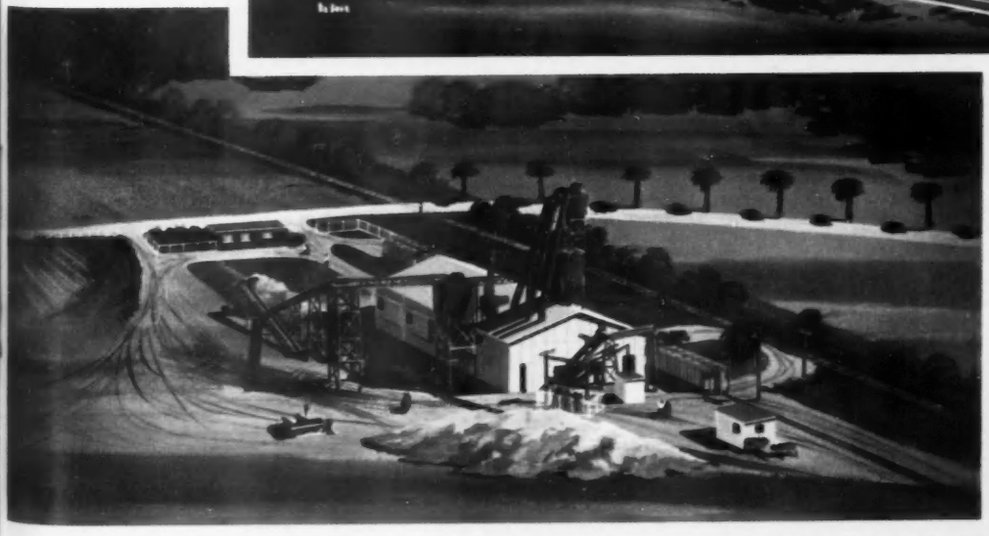

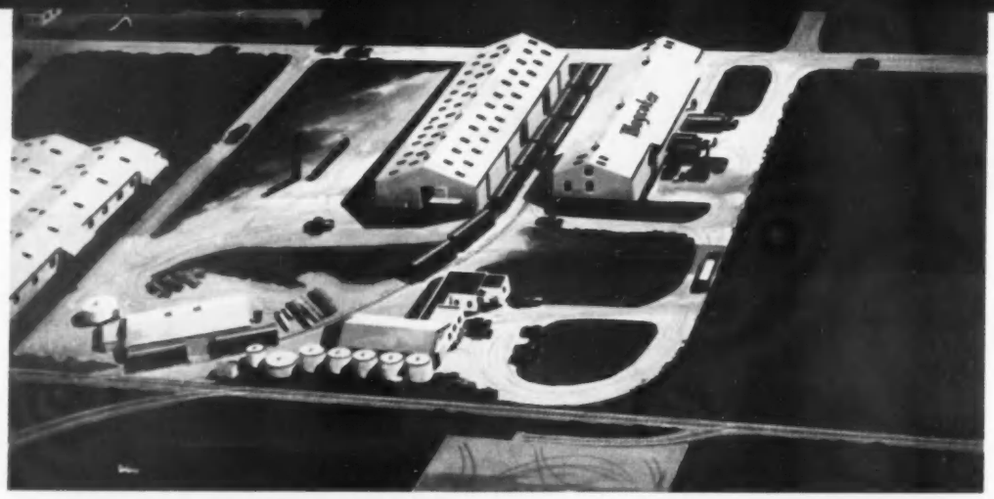

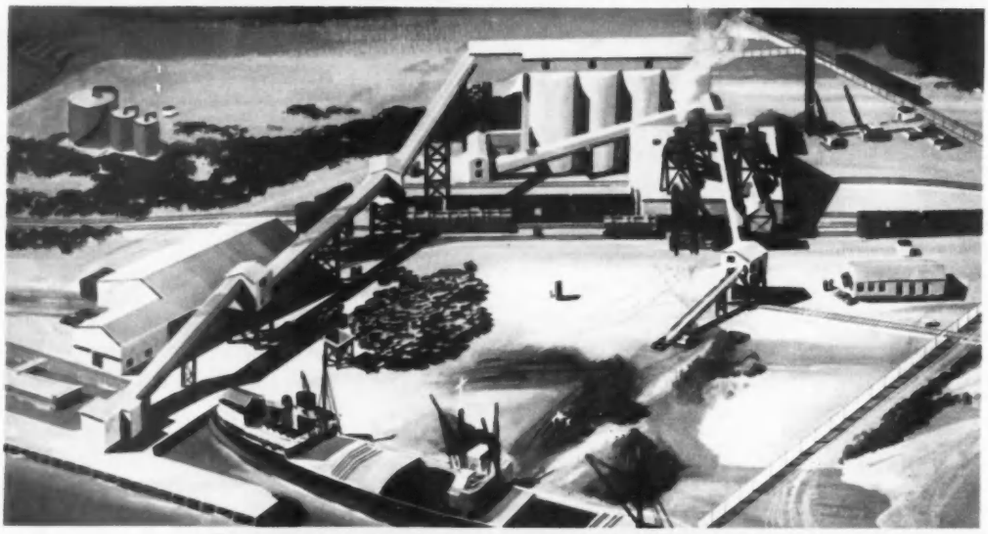

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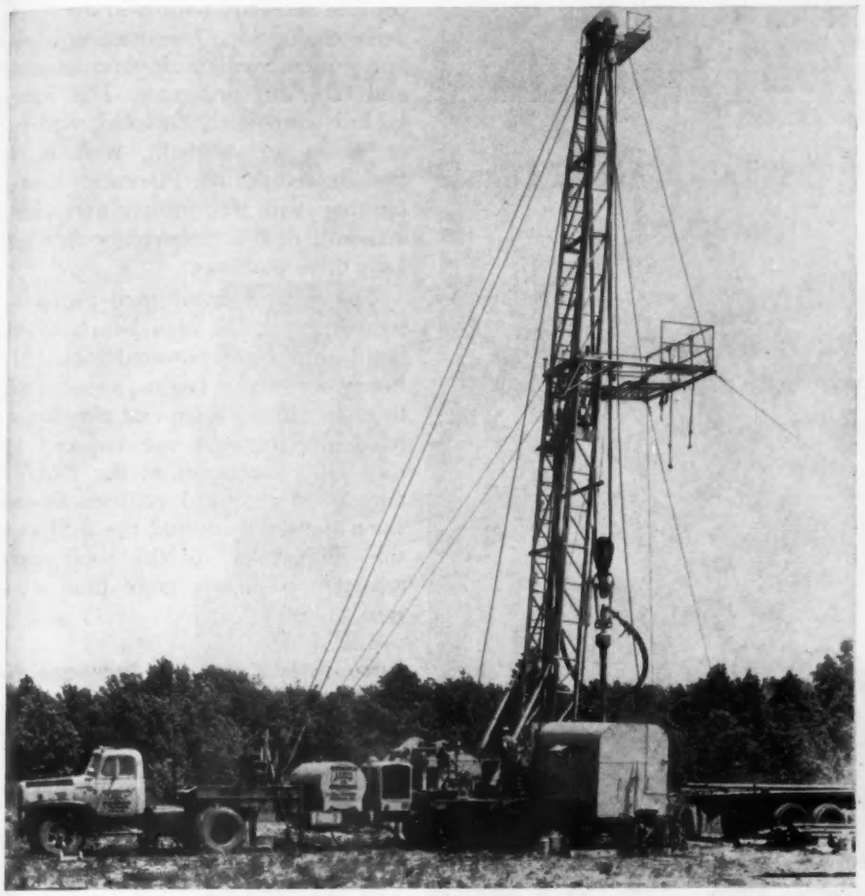


FIGURE 1—This is an over-all view of a slim hole rig with the draw works engine and mast all mounted on one trailer and the pipe trailer forming another load. Note the two-wheel trailer dog-house.

Advantages of Slim Hole Drilling in Tri-State Area

Highly portable rigs, decreased drilling and completion costs and decreased capital investment are making slim hole operations economical in this area.

By ARNOLD F. LEWIS
Lewis Drilling Company
Princeton, Ind.

As competition increases in the drilling industry, there is an ever increasing demand for more economical and more efficient methods of drilling. Low contract prices are commendable if they can be correlated with low drilling costs. From the producer's viewpoint, lower contract prices permit more extensive exploration. Moreover, such low prices can counterbalance expanding completion costs of producing wells. However, if footage prices are cut without deductions in drilling costs, such contracts become economically unsound for the contractor. The contractor has met competition to date by increasing the rate of penetration; however, today almost maximum penetration has been reached with present conventional tools, and new concepts of drilling are needed to keep pace with the industry's demands. Many contractors and producers are finding the solution to this economic equation in "slim hole drilling."

Slim hole drilling, as practiced in the Tri-State area of southern Indiana, southern Illinois and northwestern Kentucky, may be described as the drilling of holes of sizes from 5⅝-inch to 6¾-inch. Conventional rigs in this area drill holes of sizes from 7⅞-inch to 8¾-inch. Depths of slim holes drilled in this area are generally between 1500 feet and 3500 feet.

Most technical improvements, designed to increase drilling efficiency over the past ten years, have resulted in more cumbersome equipment. The slim hole rig is lighter, smaller and less complex than the conventional rig. It can therefore be operated by fewer men than the conventional rig. The chief asset of slim hole drilling is its simplicity.

Figure 1 shows a completely portable rotary slim hole rig, owned and operated by Lewis Drilling Company, Princeton, Ind., capable of drilling holes up to 3500 feet. The rig and all necessary equipment may be moved in three to four loads, depending upon the depth of the hole to be drilled.

The main load includes the draw works assembly, fuel tank, mast, and racking platform, mounted on a tandem axle, dual wheel low boy trailer. The telescoping mast is hydraulically lowered to a horizontal position on the trailer for roading. Due to the relatively light net weight of 26,000 pounds on the trailer tandem axle, no special permit is required to move the rig.

The skid-mounted mud pump and its 117 horsepower diesel engine, together with the water tank, comprises the load for the second truck.

Drill pipe, rotary table and substructure constitute the third load.

The two-wheel dog house trailer is hitched to one of the pick-ups.

Designed to Simplify. Such comparatively light weight equipment supplies a maximum of drilling efficiency with a minimum of tonnage. It was constructed according to the company's specifications, and designed to

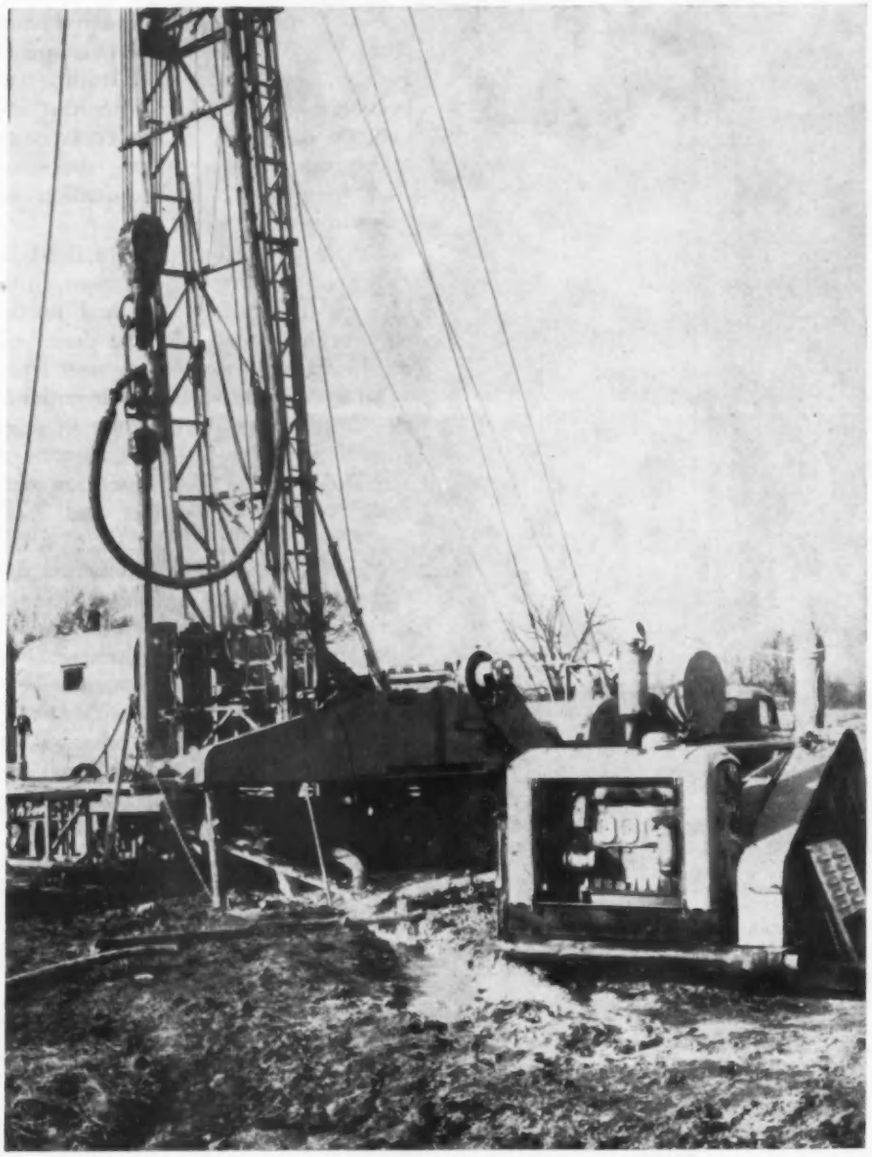


FIGURE 2—The 5-inch by 10-inch skid-mounted mud pump, powered by a 117-hp engine, supplies sufficient fluid for slim hole operations.

simplify operations without sacrificing drilling efficiency.

Power for the single drum draw works is furnished by a 117 horsepower diesel engine identical to the mud pump engine. The draw works has a free spooling, drilling line drum with air actuated friction clutch. Cathead shaft is so located that driller only has to move back on the platform to use the catline. An engine mounted air compressor supplies air for operation of rotary and drum friction clutches. All controls are located at driller's position.

The telescoping mast is constructed of structural alloy steel, with a height of 65 feet from ground to base of crown beams. Hydraulic rams raise and lower the mast from horizontal to vertical position and vice versa. The upper section is raised and lowered by means of a wire line attached to the drilling line drum. The top section of mast is provided with safety device to prevent dropping it in case of wire line failure. The island type racking platform, with adjustable fingers, has a capacity for racking 3500 feet of doubles, range 1, 2⅞-inch drill pipe. The drill pipe is set on portable mats and laid on the ground below the working floor. This is an innovation designed especially for this rig in order to decrease the size and weight of the substructure.

The rotary table is mounted on a 4-foot high substructure. This substructure is adjustable so that it can be raised or lowered to fit different heights of well head connections. It also has a horizontal adjustment to provide necessary tension in the rotary drive chain. Such construction allows ample room for flow nipple connection and blow-out preventer. The rotary table is completely enclosed, and operates in an oil bath, with a 14-inch inside opening. The rotary master bushing will accommodate either standard or slim hole rotary slips and kelly drive bushings.

The skid mounted mud pump assembly, consisting of a 5-inch by 10-inch slush pump, powered with a 117 horsepower diesel engine, supplies sufficient fluid for adequate circulation. Mud requirements are reduced for slim holes inasmuch as the required circulation rate and volumes depend upon the hole size and the drill stem size. The weight of this mud pump assembly is slightly more than seven tons.

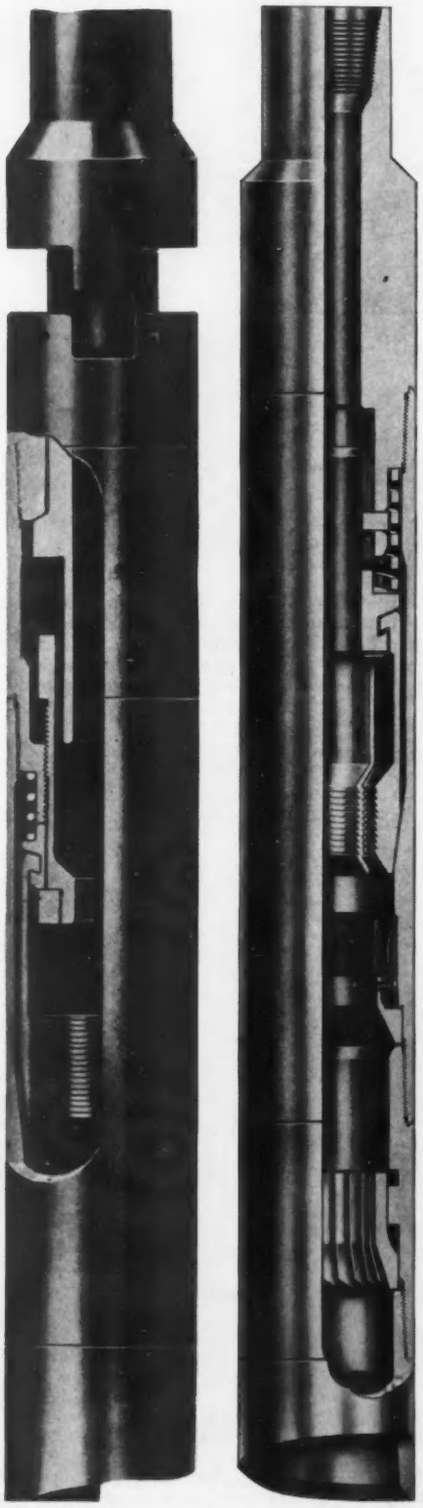
Automatic Catheads Increase Efficiency. Two automatic catheads—breakout and spinning line—increase efficiency of operation. Cathead, mast erection and rotary table controls are grouped at the driller's station.

One of the evident advantages of the slim hole rig is its maneuverability. Because of the rig's light construction, it is extremely mobile, and can travel at road speeds of 40 to 45 miles per hour. Moreover, because of its simplicity, rigging up and tearing down can be accomplished in a comparatively short time. The slim hole rig can be rigged up and turning to the right within 2½ hours after reaching location. The telescoping mast is a definite advantage in conserving rig-up and tear-down time. Also, the rig is moved with blocks strung, and, as over-all height does not exceed twelve feet, no trouble is experienced due to lack of clearance in underpasses and bridges. Another time saving feature is that the trailer frame serves as part of the drilling substructure.

The separately powered, skid mounted mud pump simplifies rigging up, as it can be placed at any convenient location. Inasmuch as mud volume requirements are less for slim holes, less space is required for mud pits or tanks. Consequently, because of such simplification, together with compact and flexible equipment, a smaller site is required for operations. It also follows that the cost for temporary

Continued on Page 216

Fishing Tools and Techniques
Part 5—Catching and Cutting Tools



Miscellaneous grappling and catching tools are necessary to bring the fish or junk out of the hole, but cutting tools are necessary when the fish is stuck tight.

By WELDON L. MEDDERS
Chief Engineer, HOMCO
Houston

FROM 1901 TO 1920, drilling depths were progressively deepening, some attaining depths as great as 5000 feet. The cable tools were being replaced in the soft coastal regions by the new steam rotary rigs. During the early 1920's the rotary method became more popular and moved into the Mid-Continent and California regions also.

The change from cable tool to rotary drilling was of great significance to the science of recovery. Limited to reciprocating action alone, the cable tool lacked the flexibility of the rotary method, wherein torque, tension, compression or any combination thereof could be used. For removing stuck objects from a well bore, twisting and pulling was preferable to pulling alone. Modern mechanical fishing tools require all available actuating forces of tension, compression, right and left-hand torque and hydraulics.

The manufacturers of fishing tools trained special personnel to assist the drilling operators in solving difficult

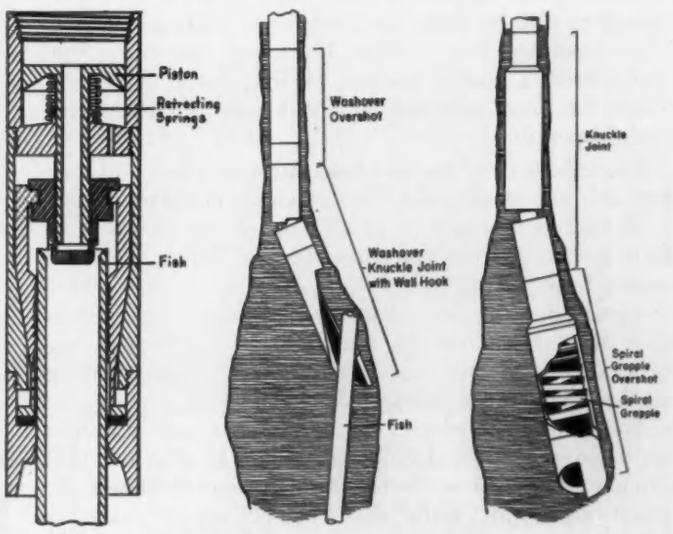


FIGURE 36—Various types of overshot designs that have been used for grappling. Left to right are: Circulating and jack screw releasing overshot; Top-loading overshot, slips are in various sizes; Hydraulically actuated overshot; Hydraulic washover knuckle joint with wall hook on the bottom; Knuckle joint with spiral grapple overshot on the bottom.

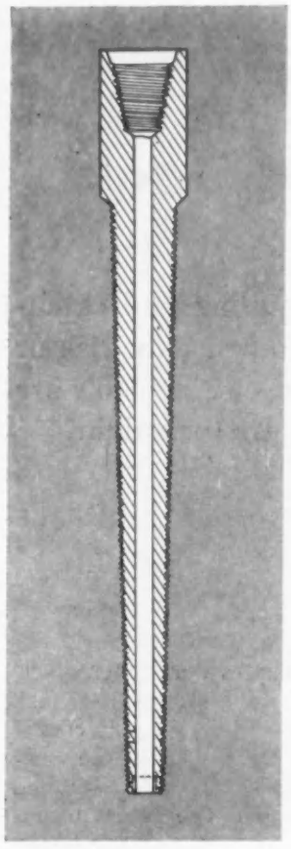


FIGURE 37—Taper tap with side kick feature. Gradual taper permits more contact per inch when engaging the fish.

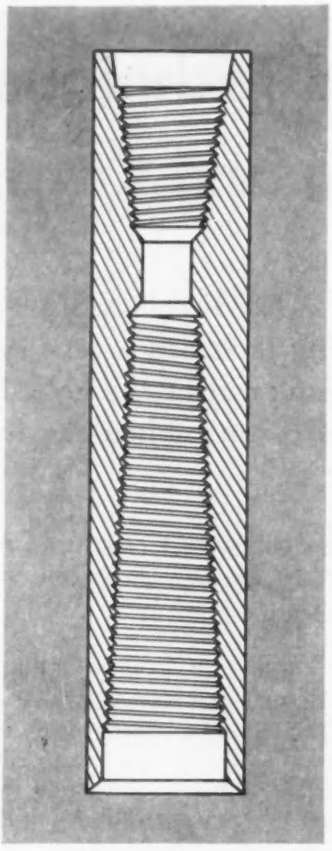


FIGURE 38—Rotary die collar, or box tap.

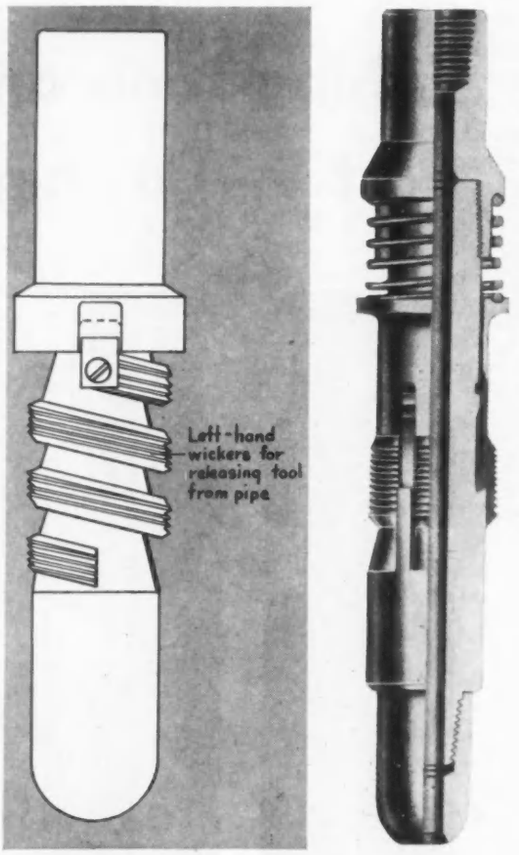


FIGURE 39—Spears with releasing mechanisms. (Left) Spiral grapple spear developed in 1935. (Center) Modern rotating and releasing spear designed to catch all types of pipe. (Right) Circulating and releasing spear. Threaded connection on bottom allows cutting tool to be run at the same time.

rotary fishing operations. These companies furnished tools, equipment and supervision.

Friction sockets, overshots, taper taps, die collars, spears, junk baskets, and jars were mostly adapted from cable tool fishing tools and a few original ideas. Figures 36 through 40 show some of the more common types and prototypes of these tools.

The left and right-hand rotation of rotary drilling permitted greater flexibility and releasing features began to be incorporated into the tools. The use of circulating fluid also proved a boon, especially in the coastal formation, where the unconsolidated sand and shale often hindered fishing operations.

The efficiency of bottom hole and side door junk baskets was also improved by the action of circulating fluid. Junk baskets are used to pick up small particles of junk such as broken rock bit cones, broken knives, slips and wipers from cutting tools, or small parts that have been dropped into the hole. Basically, for many years there have been two kinds of junk baskets, mechanical and hydraulic, with the mechanical basket dominating the market. The mechanical basket consists of a barrel or sleeve open at the bottom end and having a set of milling teeth looking down. Inside the milling head is the junk catcher comprised of 10 or 12 spring-loaded fingers disposed radially and retractable when objects are pushed in from the bottom. Once these objects are inside the sleeve, the fingers spring back into place and trap the objects.

To catch junk with the conventional basket is is nec-

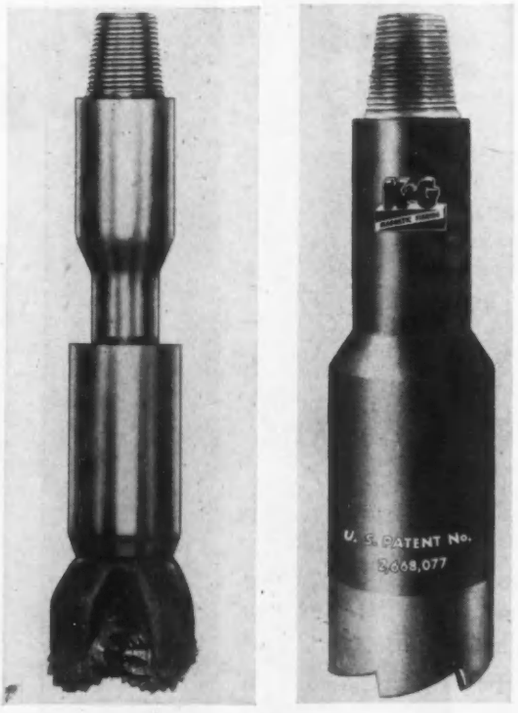
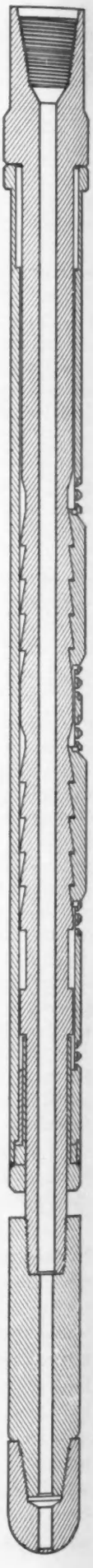


FIGURE 40—Bit basket (left) used just above the bit. Small pieces of junk are circulated off bottom and are collected in the basket. The side door basket is used for the same conditions. The magnetic fishing tool (right) is one of the most popular pieces of equipment for fishing for small pieces of junk such as bit bearings, tong dies etc.



essary for the milling head of the tool to mill into the formation a sufficient depth to force the junk up into the sleeve. In hard formation this may be difficult if not impossible.

A magnetic junk basket was developed to circumvent the need to drill with the basket. (Figure 40b). The inner pole of the magnetic junk basket consists of a permanent magnet about 12 to 14 inches long and the outer pole is of alloy steel with about a 3/8-inch gap between them. There is no trap or receptacle for the junk since none is needed. The magnetic particles lost in the hole are caught directly on the lower face of the tool and held securely

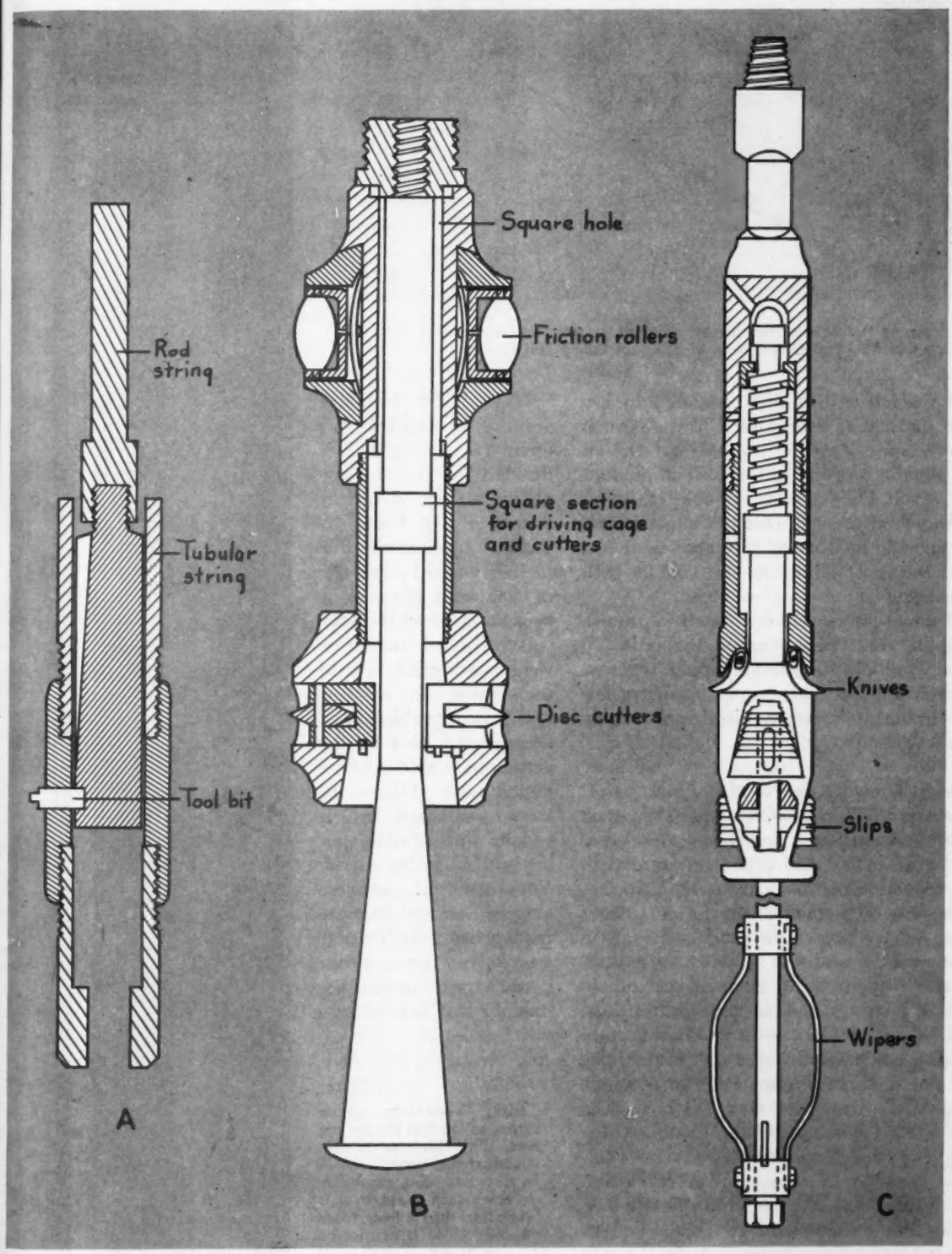


FIGURE 41—These are some of the early type inside cutters that were used. A—Inside cutter of 1870. It was actuated by a slotted and tapered mandrel, and required two strings for operation; and outer tubular string to turn the cutter and an inner rod string to actuate the mandrel. B—Inside cutter of 1877 was a roller type cutter similar to those used in pipe fitters cut-off tool. This type of design with the disc cutters dominated the field until 1920. C—This cutter of the 1920's broke away from the disc type cutters and used longitudinally disposed knives, slips and wipers. This tool established a trend in design that has influenced all modern mechanical cutters.

FIGURE 42 (Right)—A modern inside cutter that is designed to prevent overloading of the knives. Weight applied from the drilling string actuates the compression spring that controls the pressure on the knives. The performance of the cutter is unaffected by varying weights applied by the drill string.

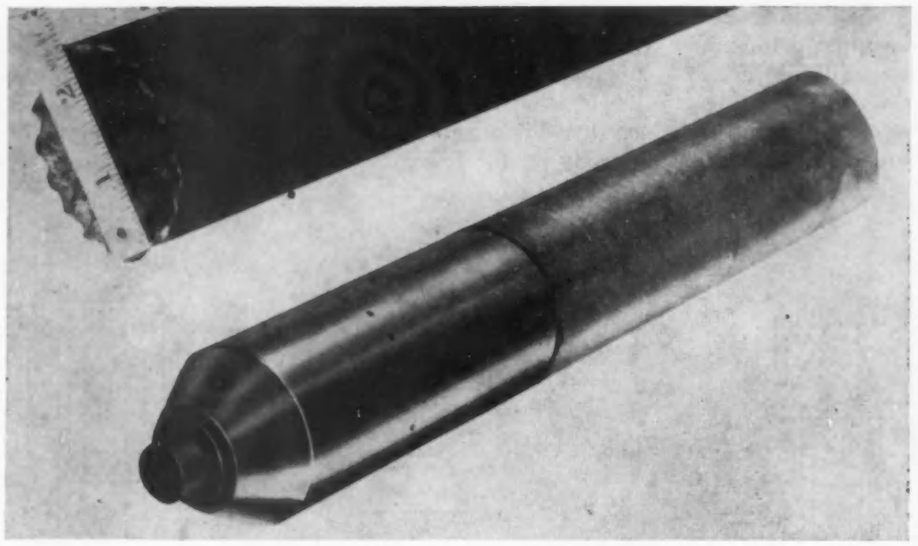


FIGURE 43—(Top) Sample of two-inch tubing cut by chemical cutter. Note absence of flare or distortion. (Bottom) Cutter head of chemical tubing cutter.

by the force of the magnet, in which position they are brought out of the hole. The lifting force of a 7⅜-inch O.D. magnetic basket is about 800 pounds and this of course is sufficient for the recovery of any normal amount of junk. The 11½-inch O.D. tool is capable of lifting about 2000 pounds of iron or steel. Due to the concentric pole design, the magnetic field extends completely across the bottom end of the tool, permitting full contact with the fish to be retrieved.

In the late 1920's, tool joints were developed to provide more efficient coupling and uncoupling of drill pipe. To increase circulation, "fullhole" tool joints rapidly replaced the joints with a restricted I.D. This change opened a new approach to the solution of fishing problems particularly with respect to stuck drill pipe.

Inside Cutters. First known string of "little inch" pipe, used in 1931, measured 1.665 inches O.D. with 2 13/16-inch O.D. tool joints screwed on. Later, joints were developed to screw on the "little inch" drill pipe and were then welded to permit reduction of the O.D. to 1 13/16 inches. This permitted the use of a small string inside smaller diameter drill pipe and tubing. This practice is still in use where circumstances require.

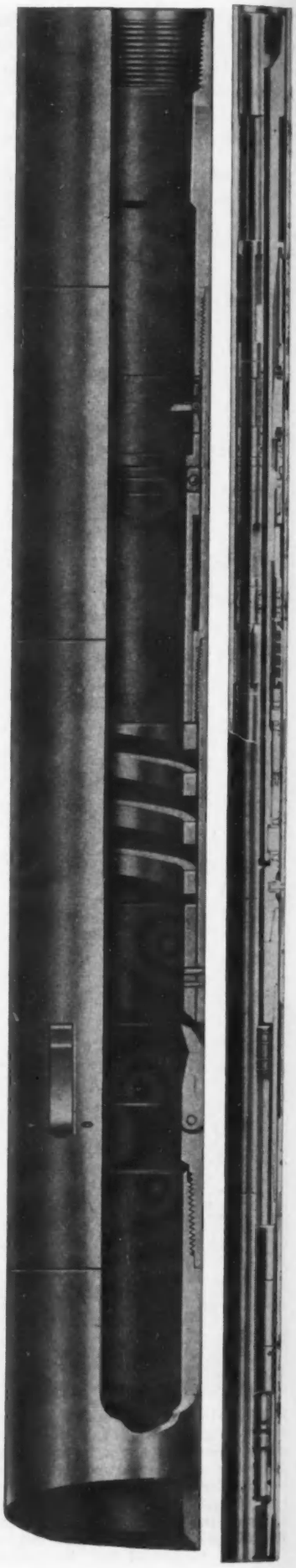
As wells deepened, pipe steels were developed to strengthen the drilling strings and as a result the pipe became more difficult to cut. The 1⅝-inch O.D. macaroni string naturally had a tendency to "wind up" in the hole. Many cuts were not completed, especially in 4½-inch drill pipe; 2⅜-inch O.D. drill pipe with 2½-inch O.D. tool joints welded on was developed. With this big "little inch," cuts could be made successfully at the most extreme depths. This method of recovery was considered revolutionary and is still being used to some extent today.

Figure 41 shows the development of inside cutters. Basically these tools have changed very little in the past 30 years. Materials from which the cutting knives are made have been greatly improved. An "automatic bottom" assembly which permits release and resetting of the tool without turning the string to the left has added to the efficiency of the operation. Probably the latest improvement in this class of tools is the spring-fed cutter.

It has been common practice to actuate and force the cutting knives through the pipe by applying weight directly from the rig floor. In shallow applications this method worked very well; in deep wells, however, it became somewhat difficult to control amount of weight being applied to the cutter. In crooked holes, this problem was accentuated. Due to the variations in sidewall friction it was difficult to know just how much weight was actually being applied to the cutter. Very often an excessive amount of weight was inadvertently applied and the knives were either burned up or broken before the cut is made.

FIGURE 44—Modern, outside cutter, spring-fed, flapper dog type. With this type of construction the spring cannot be forced to solid, regardless of how much upstrain is taken from the rig floor. Force on knife blade is unaffected by strain on pipe.

FIGURE 45—Washover drill collar spear. Of recent development, this washover spear has found great use in retrieving collars which have become stuck in key-seats.



Cutters are now on the market which preclude the possibility of overloading the knives. In operation the knives are fed outwardly into the cut by means of a compression spring (Figure 42). This spring is actuated by weight from the drilling string. However, this weight is no longer critical in the performance of the tool. The string weight on the tool may vary over a wide increment, say from two thousand to twenty thousand pounds, and the performance of the cutter will not be affected. The only force acting against the knives is that of the compression spring. With this method, depth and crookedness of hole no longer adversely affect mechanical pipe cutting.

When cutters are run with a spear and hydraulic pulling tool, they make today's inside cutting jobs a far cry from jobs that took place in the 1920's and 1930's. At Humble in 1936, a typical job was performed at 1800 feet. A 3½-inch button screen had been set inside of 5½-inch button screen. A mechanical perforator was run and an attempt made to perforate. The old "shop-made" mechanical tool would merely bulge out the soft inner pipe instead of piercing it. After many attempts the tool was retrieved and, since the soft inner screen was sanded up, it was decided to cut and pull. Twenty-four cuts were made over a period of 18 days, pulling six inches at a time. The bulges in the pipe acted as anchors in the tight sand and made it impossible to pull more than six inches at a time. To further complicate the operation the cutting knives in their fully expanded position would cut through the pipe but not through the bulge. This made it necessary to pull this part of the pipe in two from the rig floor.

The price per cut on this job was $35 as compared to today's price of $192.

The most recent approach to inside cutting is the wire line chemical cutter (Figure 43). This tool reaches its greatest utility in deep crooked holes where it is not possible to get sufficient torque downhole to back the pipe off in the conventional manner. This tool is of rather simple construction. It consists of three chambers. The upper chamber houses a slow-burning explosive similar to that used in wire-line packer setting tools. The middle chamber contains the cutting charge, a compound of fluorine and other members of the halogen family. The lower chamber contains a catalyst which promotes the instantaneous reaction of the halogen compound. Spaced evenly around the bottom of the tool are orifices, or nozzles, through which the chemical is forced. To actuate the tool in the hole, the slow-burning charge is set off electrically and the expansion of gases in the upper chamber force the cutting compound and catalyst through the lower orifices. High velocity and high temperature combine to produce a quick, smooth cut.

The chemical cutter has several advantages:

1. The O.D. of this tool is not limited, and it can go inside 2-inch tubing.
2. The tool is run on a wire line; saving rig time.
3. The chemical makes a clean cut, compared to the belled effect produced by a shaped-charge or explosive cutter.
4. Rotation of the pipe is unnecessary. Only a slight upstrain need be taken on the pipe.
5. The cut may be controlled by varying the amount of chemicals. In other words, tubing may be cut without damaging the casing.

Outside Cutter. The basic construction of outside cutters has remained unchanged since the early 1920's. These tools were the only means of mechanically cutting drill pipe and tubing until the early 1930's when "little inch" pipe made possible the cutting of this pipe from the inside.

The early outside cutting tools were particularly inefficient because of the long knives that were used. Just before cutting through the pipe, the long knife, unsupported over most of its length, would begin to chatter severely and the cut would be missed. After the tool was pulled and repaired, a cut would then be attempted a joint higher, and so on, until sometimes five or six joints of pipe would be ruined before affecting a cut. It was not until after World War II that major improvements were made in these tools.

Shorter knives materially reduced chatter. The knives were fed inwardly into the pipe by upstrain from the rig floor. As noted previously in the evolution of inside cutters, when wells deepened it became increasingly difficult to know just how much pressure was being applied to the knives. The ratio of miscuts to cuts was embarrassingly high. To overcome this limitation, a compression spring was placed in the cutter above the knives (Figure 44) in such a manner that, regardless of how much upstrain was taken from the rig floor, the knives would be fed into the pipe only by the compressive force of the spring.

A significant innovation in outside cutters appeared in 1953, when the bottom loading, or outside cutter with retractable knives, appeared on the scene. This tool is exactly like the spring-loaded cutter mentioned above except that, after a cut is made, the knives retract back into their original position in the body of the tool.

This feature allows the pipe to be brought out of the hole only to the point where the top of the cut fish presents itself at the rotary table. Then, with the washpipe hanging in the slips, the fish is stripped out, and the washpipe and cutter are again lowered away, never having been brought out of the hole. Obviously, this saves considerable time per trip.

On one job in the Houma area, a 5⅝-inch outside cutter with retractable knives was used inside of 7-inch casing to clean out a string of 2½-inch tubing which was sanded up as a result of a salt water flow. Washing down with a clustered carbide rotary shoe at high rpm's, five consecutive cuts were made on 2½-inch H-80 tubing during a 24-hour period without once removing the cutter or washpipe from the hole, 2473 feet of pipe were extracted in what might be called a single run. An examination of the cutter after the completion of the job showed the knives to be in good condition.

Washover Drill Collar Spear. Another simple mechanical tool of recent origin is the washover drill collar spear. This tool cuts down the number of trips necessary to retrieve drill collars which have become stuck in key seats.

Prior to the advent of this tool the general procedure in recovering keyseated collars was as follows: first, the free pipe was backed off just above the collars; then, a washover operation was begun. After washing over the stuck portion, the freed collars would fall to the bottom

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of the hole. The wash string was then pulled and an overshot or spear run in to pick up the collars. Sometimes, upon arriving on bottom with the grappling tool, the collars would again be stuck; whereupon the fishing string would have to be pulled and another washover operation begun.

Under the old method it was necessary to make two to four trips to recover keyseated collars.

The washover drill collar spear has reduced the number of runs to one and has therefore reduced fishing time to the time actually required to wash over the collars. Work that formerly required several days now requires several hours.

Figure 45 shows a washover drill collar spear. The operation of this tool is as follows: This tool is generally located in a bushing between the first and second joint of washpipe so that the mouth of the rotary shoe will be well over the fish before the lower pin connection of the inner spear assembly contacts and screws into the fish. This inner spear assembly consists of the spear proper, with the lower end affixed to a set of bumper jars having a 3-foot stroke. Below the jars is a pin-type safety joint with a "J" slot. On the bottom of the safety joint is a sub with the proper pin connection, down, to screw into the box of the pipe. When going in the hole, this inner spear assembly is held in a fixed position in the washpipe bushing by means of the slips on the spear which are in the expanded or catch position. After the rotary shoe contacts and passes over the upper end of the fish, the lower pin connection on the spear assembly then approaches and is screwed into the box of the pipe or drill collar, the necessary torque is transmitted from the washpipe to the inner spear by means of the four slips. After the tool is secured to the drill collars, by means of a down stroke jarring action provided by the set of bumper jars connected to the lower end of the drill collar spear, the slips are released and the wash pipe is then free to turn independently of the spear mechanism. The washover operation is begun and, after a sufficient depth has been attained, the wash pipe is picked up. The six slips in the spear are actuated, catching on the I.D. of the washpipe and allowing the free collars to be pulled from the hole. If, however, during the washover operation the collars should suddenly become free and begin to fall, the slips will be actuated in the same manner as noted above, thus holding the fish securely inside the wash pipe. In addition to these features, through a "J" slot on the spear mandrel, the tool can be hooked up in the released position, allowing the wash pipe to be pulled upwardly without causing the slips to set. In this way, a connection can be made at any time without releasing the safety joint.

It should be noted that the slips work in longitudinal slots in the mandrel, thereby keying these two members together. In this way left or right-hand torque can be transmitted from the wash pipe to the tool and the fish below, a feature which allows a backoff to be made at any time during the washover operation.

The cage on the spear is made in two sections, the lower half containing the wipers being free to rotate on the mandrel in the released position. Thus, when washing over, the wipers will be free to rotate with the wash pipe, reducing wear on these parts to a minimum. The upper part of the cage remains in a fixed position on the mandrel since the slips are actually keyed to the mandrel for

TABLE 8—Drill Collar Spear Report

Job No.	Area	Description	Size W.P.	R.P.M.	Length of Fish Washed Over	Time Req'd to Complete	Remarks
1.	Brookhaven, Mississippi	4½" drill pipe, 3–6" OD drill collars and packer	7"	80	5425 Feet	288 Hours	Washing over and backing off in 7⅞" hole. Wilcox formation consisting of hard shale with streaks of lime.
2.	Brookhaven, Mississippi	Drill pipe	7"	80	1357 Feet	72 Hours	7⅞" hole collapsed while setting cement plugs. Ran 485 ft. 7" wash pipe and made 3 backoffs w/drill collar spear. Cleaned out the hole in 3 days.
3.	Brookhaven, Mississippi	11–6¼" OD drill collars	7⅝"	85	360 Feet	12 Hours	Total depth of 9" hole was 12,200 ft. Customer was stuck in keyseat at 3,350 ft. Total operation including picking up, washing over and laying down 365 ft. wash pipe completed in 12 hours.
4.	Brookhaven, Mississippi	6–6⅛" OD drill collars and 5 jts. 4½" drill pipe	7⅝"	60	330 Feet	9 Hours	Customer stated this was the fastest fishing job ever done for them, as they were back in the hole drilling at 9,000 ft. within 24 hours after we arrived on job.
5.	Brookhaven, Mississippi	4–5¾" OD drill collars	7"	5	330 Feet	4 Hours	Tool worked perfectly on this job. Total depth of hole was 6,020 ft. w/pipe stuck under surface pipe. After washing within 20 ft. of the bit, the fish fell and spear caught, retrieving fish.
6.	Brookhaven, Mississippi	3–6⅜" OD drill collars, 2 packers and 4 jts. drill pipe	7⅝"	60	208 Feet	9 Hours	Customer had run a drill stem test w/straddle packers in 8¾" hole and had 3 drill collars on bottom of packers. After making test he could not move his pipe. Upon washing over 1 packer and down to the next one, we were able to pull the entire string as the drill collar spear was anchored in top of fish.
7.	Brookhaven, Mississippi	3–6" drill collars, 1–3-blade reamer and 2 jts. drill pipe	7⅝"	30/60	163 Feet	15 Hours	Working in directional hole 17° off vertical. Collars sticking in hole while pulling fish. Washed collars free. Released spear from wash pipe; slacked fish back to wiper sub. Set slips.
8.	Brookhaven, Mississippi	8¼" OD whipstock w/ 245 ft. 4" drill pipe in 17° directional hole	7"	30/50	257 Feet	12 Hours	Whipstock stuck in crooked hole.
9.	Brookhaven, Mississippi	6–6⅛" OD drill collars	7⅝"	60	212 Feet	5 Hours	Released tool 12 times and reamed every joint. Tool released good after getting fish to top of hole. Slacked tool back down in wash pipe to wiper sub. Layed down wash pipe. Tool worked perfectly.
10.	Houston, Texas	8–7" OD drill collars	7" and 8⅝"	40	425 Feet	16 Hours	Washed over about 125 ft. of 7" collars and fish fell, shaking rig.
11.	Houston, Texas	6–6¼" and 6½" drill collars and 2 jts. 4½" drill pipe	7⅝"	40/50	241 Feet	3½ Hours	Tool worked perfectly.
12.	Victoria, Texas	4–6¾" OD drill collars 3–7½" OD drill collars	8⅝"	84	201 Feet	20½ Hours	Rotary shoe plugged with shale and flowback sheared drill collar shear pins. Spear floated up to top of 6th joint of wash pipe. After screwing into fish, wash pipe could not be moved either up or down. Safety joint was broken and spear brought out of hole.

Total Footage	9,509 Feet
Total Hours	466 Hours
Average Footage per Hour	20.41 Feet

the purpose of transmitting torque from the wash pipe to the safety joint and fish. It should also be noted, as shown here, that the slips in the released position are securely held in the retracted position by compression springs, thus preventing wear on the wickers during the washover operation.

It can be seen that the several mechanisms used in this device are modifications of old tools. This tool is a descendant and facsimile of the stringer type spear (a tool which has been around for decades) plus a bumper jar and a pin type safety joint. Nevertheless, this tool represents a great improvement in efficiency.

Table 8 gives the results of a number of field runs. On jobs #1 and #2 the tool was used for washing over and backing off, recovering 5425 feet of fish on the first job and 1357 feet on the second. In this usage, the tool performs the same function as a washover-backoff connector as described in Part 3 of this series.

Each down-the-hole fishing and grappling operation poses a separate problem, but due to the standardization of equipment and the confinement of a well bore some of these problems have occurred with sufficient regularity to warrant trying tested and proved recovery methods. Thus a number of tools that started out as improvisations have become standard as well as the techniques for their operation. Most of these standard tools and techniques with some case histories have been presented in this and preceding installments. Tomorrow's job may necessitate modifying the existing tools and techniques—these in turn may become the standard fishing tools and techniques of the future.

The sixth and final installment of this series will appear in the July issue of WORLD OIL and will deal with the training of personnel in the techniques of fishing.

Slim Hole Drilling in Tri-State Area

Continued from Page 208

roads and bridges into locations is reduced. Thus, moving, rigging up and tearing down can be accomplished in hours instead of days.

In drilling operations, bit and drill string requirements for slim holes may vary according to the character of formations. It has been determined that drilling in the Tri-State area can be adequately performed, using 6¼-inch bits and 2⅞-inch drill string. In this size hole, the producer sets 4½-inch casing.

Due to the fact that small diameter drill pipe or tubing is used, it has been the policy of this contractor to apply the weight of the drill collars only to the bit. The number and weight of drill collars run depend upon formations encountered.

Efficient drilling operations are maintained by a crew of three—the driller, the derrickman and the floorman. When making trips, the driller's regular position is at the controls of the automatic cathead, hoisting drum and rotary table.

In tripping out, the floorman sets the slim hole slips and latches both tongs while the driller operates the break-out cathead and rotary table.

Tripping in, after the floorman sets the rotary slips, the driller steps out one step from his position at the controls, latches the make-up tong, and steps back to the controls, ready to engage the make-up cathead, as the floorman sets the back-up tong.

The derrickman is responsible for the operation of the mud pump.

Slim Hole Drilling Is Economical. Perhaps the most attractive advantage of slim hole drilling, from the viewpoints of both the contractor and the producer, is the economic advantage.

For the producer, there is reduced footage price and less day work or rig time cost. This is made possible by simplified slim hole operations and fewer men required to man the rig.

For exploration, the advantage is indisputable. In wildcatting also, more economical drilling permits more extensive operations.

On producing wells, the big item of savings for the producer is in completion costs. In casing alone, there is a savings of over one third as compared to conventional casing programs in this area. For example, in this area, the price of 4½-inch continuous weld casing is $104.48 per hundred feet, whereas the price of 5½-inch casing is $163.30 per hundred feet. There are also savings in cementing and other minor completion costs.

For the contractor, aside from a smaller capital investment and less maintenance expense, many consequent savings are realized. Man hours for moving, rigging up and tearing down are cut to a minimum. There is a considerable savings in fuel costs as the fuel consumed averages about one gallon per foot drilled for mud pump, hoisting power and rotary drive. The lesser volume of mud required also reflects a considerable saving in cost. A decided savings in price of slim hole bits is realized, as the price decreases according to bit size.

Thus, slim hole drilling has become an effective and economical process. Its equipment is compact and flexible. Its operation has been simplified to a minimum, while complete drilling efficiency has been maintained. For shallow production, it has been proved that slim hole drilling can successfully satisfy the drilling industry's demands in this area. —**The End**

About the Author

ARNOLD F. LEWIS has been active in the oil business for 25 years as a producer and drilling contractor. Previous to World War II, his operations were in eastern Kansas. After serving 2½ years in the U. S. Navy, he located in Princeton, Indiana, where he has concentrated on slim hole operations in Indiana, Illinois and Kentucky.

From past experience, Lewis developed ideas for innovations in the slim hole rig.

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You're right, that's me standing there watching a good crew coming out of the hole. ★ And a pretty sight it was too, to see 'em handle those Web Wilson Links, Elevators and Elevator Stabilizer—all of them a big help to fast-moving crews. ★ Makes me wonder whether *your* crews are using those Web Wilson "Small Eye" Links which are drop forged from a single billet of high quality steel, and bent inwards just right both top and bottom to let the elevator swing easily. They are normalized and heat-treated to develop strength and toughness, then quenched in a vertical tank to avoid any bending or warping—it's not good to straighten links *after* heat-treatment. ★ You really ought to be using them. ★ Reckon you already know how good Web Wilson Elevators are—the Center Latch kind with a Safety Latch that keeps 'em closed, and a self-opener that saves the crew plenty of work. ★ Their Side Door Elevators for casing are superfine too.

Guess that's enough selling for today, so I'll knock off and tell you a couple of jokes that tickled my funnybone. One of 'em is a poem...

Of all the fishes in the seas
I'm fondest of the bass.
He climbs the highest sea-weed trees
And slides down on his hands
and knees.

The other is about a census taker who was really surprised when the lady of the house told him that she was the mother of three sets of triplets. "Do you mean to tell me you get three every time?" he asked. "Oh, no," she replied, "sometimes we don't get any at all!" ★ It's that way peddlin' oil tools, too—some days I get three orders, and other days... well, just like the lady, I don't get any at all. But, it's a lot of fun!

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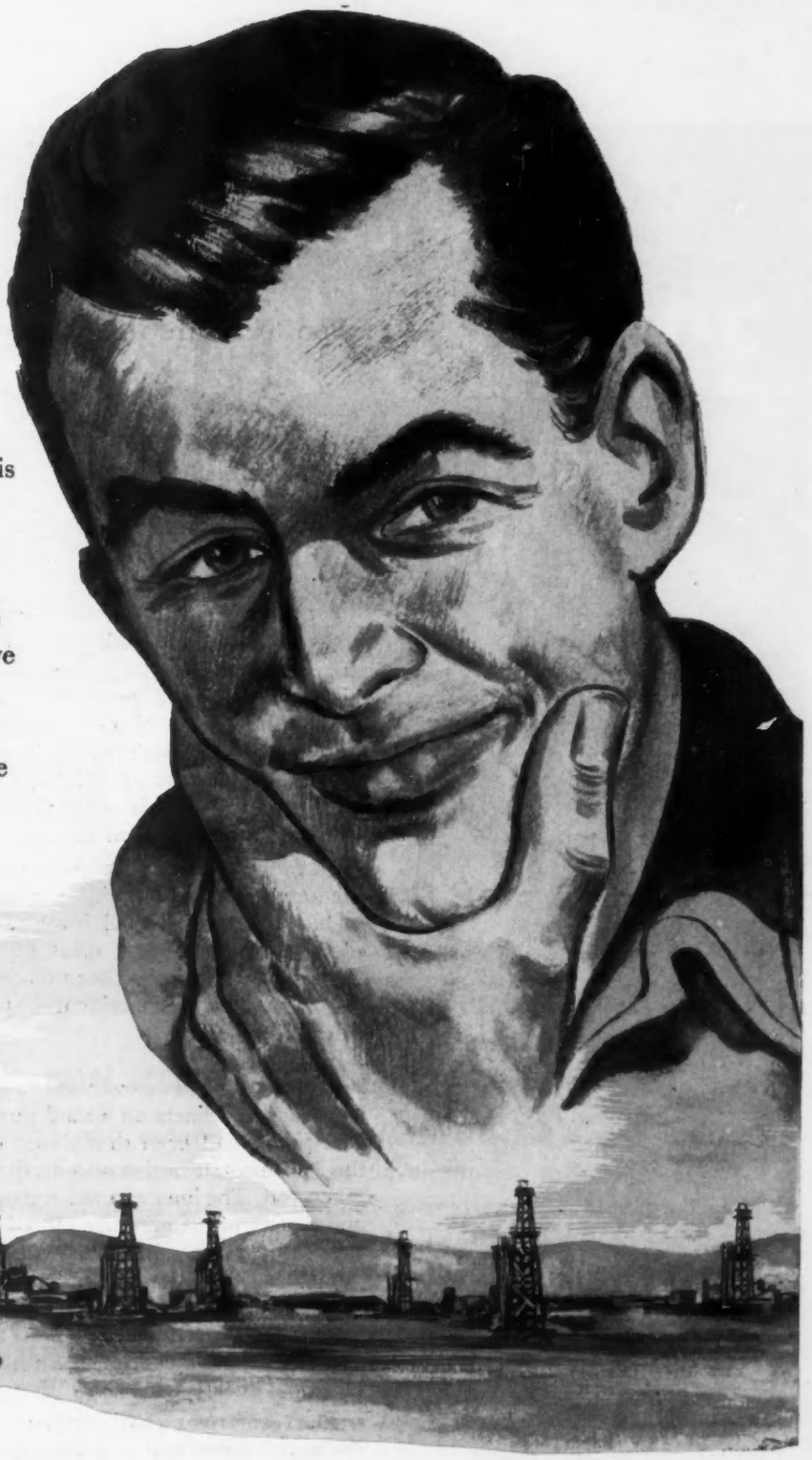

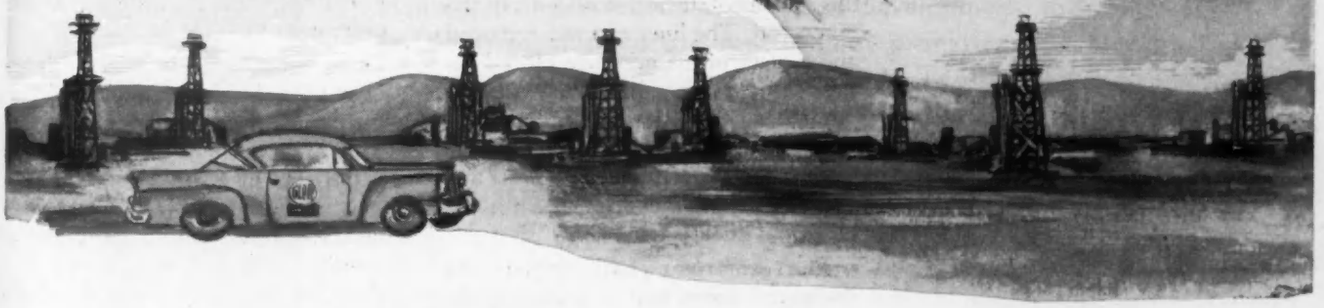

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Accident on the Rig—a Case History

How and why an accident happens and steps taken to assure that it does not happen again.

By ANTHONY GIBBON
World Oil Staff

Recently a driller working on a rig 60 miles south of Grande Prairie in Western Canada suffered a painful injury. His shoulder was dislocated.

An investigation disclosed that if proper precautions had been taken this accident would never have occurred. The nature of the accident is such that serious consideration is warranted on the part of drilling contractors and drillers in order to avert a repetition of this occurrence.

To fully appreciate the nature and circumstances of this accident, and to enable drilling personnel involved to adopt precautionary measures to guard against a similar occurrence, a case history of this accident is presented here.

Description. The crew was changing heads and liners on a mud pump. The pump had been shut down and the intermediate rod screwed off the pump rod. The liner cap was removed and a piece of material was placed between the intermediate rod and the pump rod. The pump guard had been removed and the driller went to the V-belts on the pump flywheel and started to pull the belts to push the head and liner assembly out.

The motorman had helped tear the pump down and unknown to the driller he went to the air valve controlling the pump at the driller's position, and engaged the clutch to turn the pump over so the head could be driven out in this manner. As mentioned above the driller was holding onto the belts and he was thrown away from the belts suffering fairly serious injuries to his shoulder when the air clutch was engaged. It was the opinion of the company personnel who investigated this accident that the injured man is extremely fortunate to be alive.

Cause. The motorman who engaged the pump controls thought that the driller was in the dog house. The pump controls were too far removed from the pump for a single control installation. Although the practice of turning a pump over with the power to drive out a head is fairly general, it is unsafe and impractical from an economical standpoint.

Recommendations. This report should warrant serious attention by all drilling personnel because it is known that accidents of this type have occurred in other operations resulting in injury and equipment damage. Fatal accidents are bound to occur if unsafe practices are continued.

- At no time should any man engage a clutch without knowing where every crew member is.
- The company concerned in this accident has decided to place an intermediate pump control between the driller's position and the pump. It is felt that all companies who have only one set of controls should place another set as near to the pump as possible. Whenever any work is done on the pump (even the shortest jobs such as placing a nail in the pop valve) this master set of controls should be disengaged. To be 100 percent safe the controls should be locked out.
- The practice of driving out heads and liners by means of power should be discontinued. The head and liner may be removed safely by turning the pump over manually providing that good teamwork is used.

—The End

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Batch-Type Gas Cycling Recovers More Oil

Alternately producing and repressuring a reservoir with gas promises efficient, economical oil recovery. This is especially true in deep, non-homogenous reservoirs where conventional gas cycling is relatively ineffective.

By ALTON B. COOK
U. S. Bureau of Mines
Bartlesville

FROM A STUDY of methods of predicting the performance of semidepleted oil reservoirs used for gas storage made recently by Bureau of Mines engineers, it was concluded that the amount of oil recoverable by repressuring and cycling a reservoir may be as great as that produced during primary-recovery operations. It appeared also that the normal operations of a gas-storage project would generally gas-sweep a larger part of a reservoir than gas cycling at essentially constant pressure, especially in unfractured reservoirs with large variations in permeability.

The flow of fluids in a reservoir used for gas storage differs from that in reservoirs subjected to gas cycling. In normal gas-cycling operations in nonhomogeneous reservoirs the reservoir pressure is essentially constant, and the major flow of gas is through the more permeable zones. When a reservoir is used for gas storage, the oil-recovery operation may be in effect an alternate repressuring and partial depletion process. For brevity, this process is referred to herein as "batch gas cycling." During periods of gas injection the reservoir gas pressure is increased, which permits gas to flow also into the less permeable zones of the reservoir as it flows into the more permeable zones. Likewise, during periods of gas withdrawal the reservoir pressure is reduced, and there is flow of the reservoir fluids (owing to their expansion) from all zones of the reservoir toward the producing wells. This procedure causes gas to flow through all zones, which results in a more efficient sweep of the total reservoir. The same alternate compression and expansion procedure as is used in gas storage can be applied when gas is used for pressure-maintenance operations during primary production and should result in a more efficient gas sweep of a reservoir. Also, this procedure can be applied in many reservoirs at any stage of depletion by primary production, with or without using the reservoir for gas storage.

No data are available to prove or disprove the author's theory that batch gas cycling will be more effective than conventional gas cycling in flushing oil through zones of low permeability of a reservoir. This would be difficult to prove by laboratory experimentation. It is likely that final conclusions as to the validity of the theory can be derived only from the results of future field case histories.

During Primary Production. Batch gas cycling probably could be used in many oil fields during primary production and should result in greater ultimate recovery of oil than conventional gas cycling. It could be used more economically where two or more reservoirs are close, either in the same field or in nearby fields. In a reservoir using batch gas cycling, oil production and gas injection will not occur at the same time. First, enough fluid should be produced to lower the reservoir pressure 10 to 25 percent if the oil is undersaturated by that amount before gas injection is begun. Then gas should be injected, while the producing wells are shut in, until the pressure in the reservoir has been increased to approximately the initial reservoir pressure. By using two or more reservoirs as one operating unit, the produced gas from one reservoir, after passing through a high-pressure separator, can be compressed and immediately injected into another reservoir in the unit. Thus, one compres-

Repressuring and batch gas cycling a reservoir promises to be a successful method of both primary and secondary oil recovery. The value of the gas injected into an oil reservoir can be recovered from the sale of the increased oil produced. As a result, owners of gas reserves can indirectly market their gas without resorting to interstate gas shipment.

Not only will the value of the gas be received from the production of extra oil, but a gas reserve will remain after the oil has been produced. By that time the dollar value of the gas reserve should have increased.

It also seems likely that by then the local demand for gas will also have increased to the extent that interstate shipment of gas will not be so enticing. If not, perhaps the present confusion and control of interstate transfer will be less bothersome.

This method of utilizing gas to increase oil recovery would benefit the state in which it was used by: (1) recovering oil that would otherwise be lost and (2) withholding gas from interstate shipment which would add an incentive for industry to move its manufacturing plants to the source of gas. Also, it seems likely that many more reservoirs will be needed for gas storage operations in the future. These reservoirs, after all producible oil has been recovered, would be good for gas storage.

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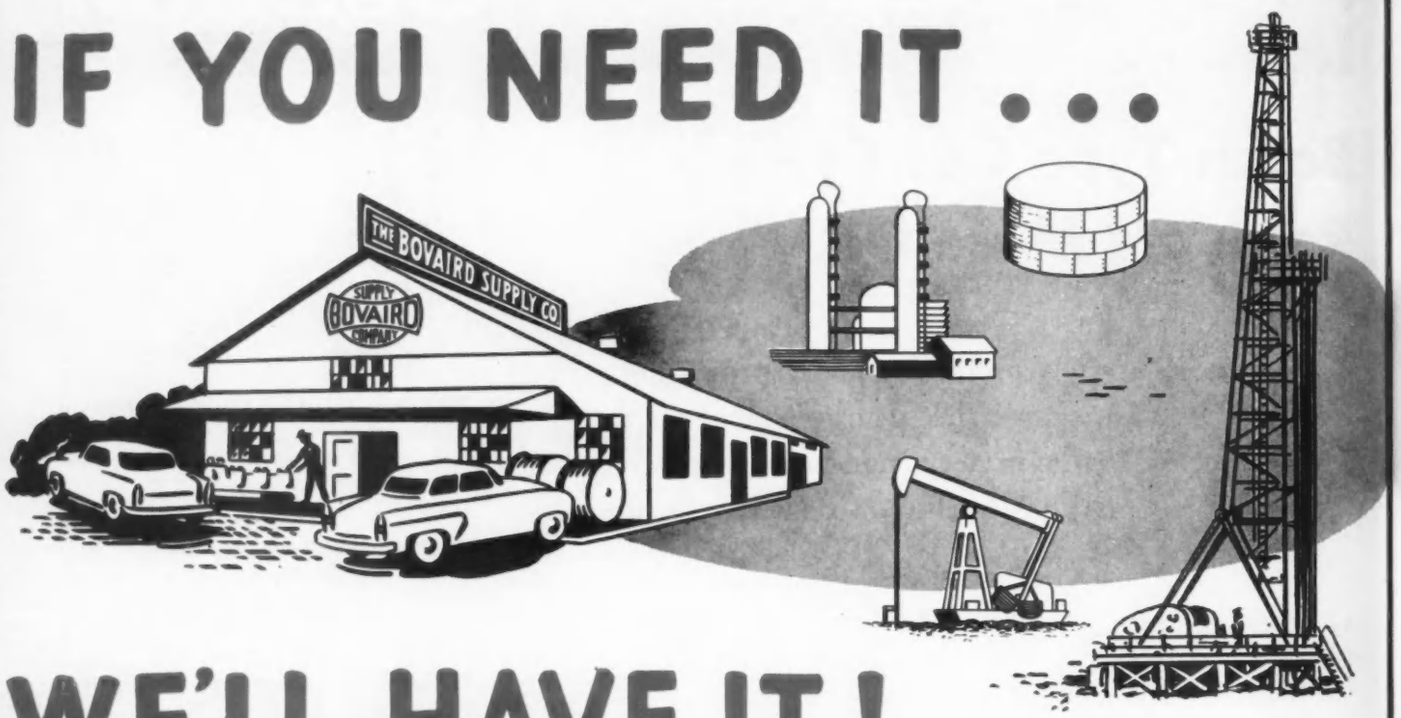

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a fair degree of accuracy. Other fac-

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free gas produced because it is rein-

voir in the unit. Thus, one compressor station can serve all reservoirs in the unit and the equipment thereby will be in operation constantly.

Figure 1 shows how fluid might be produced from one reservoir while the produced gas was being injected into a second reservoir. The phase of batch gas cycling illustrated is that of repressuring the top reservoir with gas derived from the producing wells completed in the bottom reservoir and from a makeup gas supply. This phase of the operation would be terminated when the pressure in the upper reservoir reached the initial reservoir pressure. Then gas injection would be started into the lower reservoir while oil and gas were produced from the upper reservoir. These cycles would be repeated as long as the operation was profitable.

For the most efficient use of such a production practice, enough gas should be obtained from outside sources so that each reservoir may be repressured completely on each cycle. However, batch gas cycling with only the gas available in the field should result in greater ultimate oil recovery than conventional gas cycling without makeup gas.

It is desirable to produce a comparatively large volume of oil during each production phase of batch gas cycling to make room in the reservoir for a sizable volume of gas during repressuring. However, there are some limiting factors to the volume of oil that should be produced. The reservoir pressure should not be reduced to the extent that the producing wells will not flow naturally or the production gas-oil ratio will be considerably greater than the solution gas-oil ratio. Enough oil could be produced from most reservoirs containing oil undersaturated with gas to lower the reservoir pressure 10 to 25 percent during each production phase, while the producing well flows naturally. From about 4 to 8 percent of the oil initially in place could be produced from most reservoirs, containing oil with saturation pressures at or near the initial reservoir pressure, during the first step, with the production gas-oil ratio being about the same as the solution gas-oil ratio.

When a closed-type reservoir containing undersaturated oil is first repressured, the volume of gas injected will depend primarily on (1) the compressibility of the reservoir liquids and

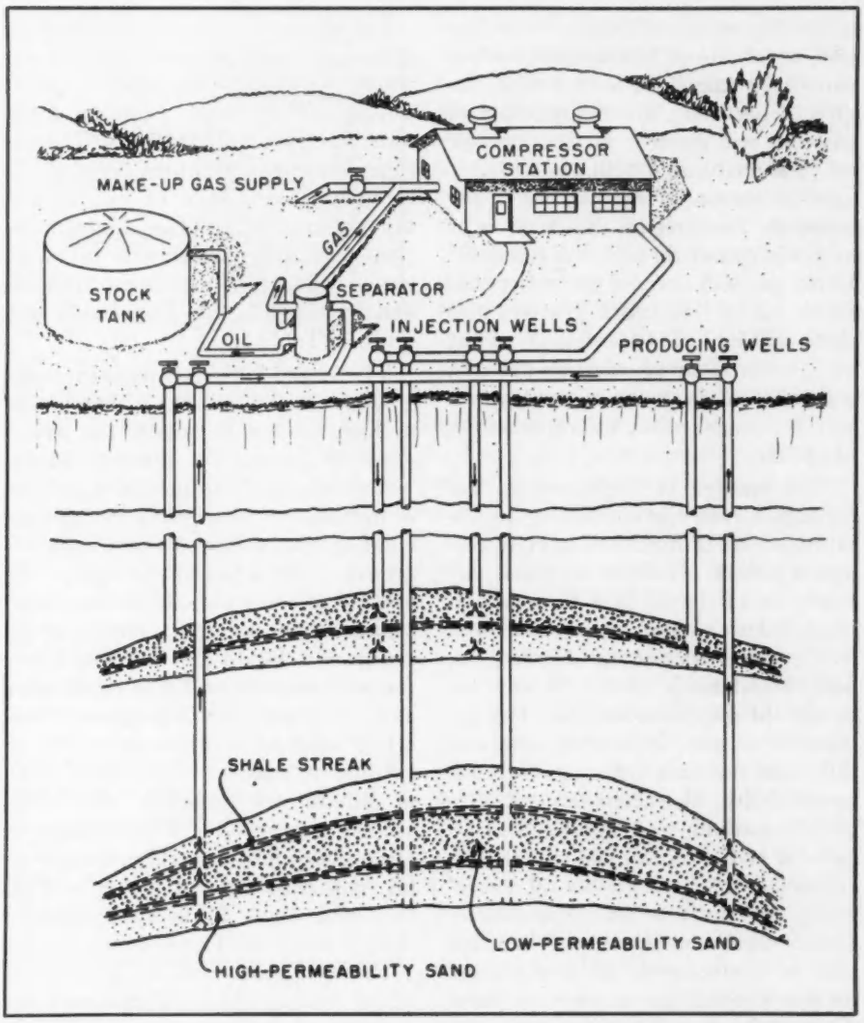

FIGURE 1—This is a schematic drawing showing a phase of batch-type gas cycling in a two-reservoir field where the top reservoir is being repressured with gas produced with oil from the bottom reservoir.

rock, (2) the volume of the reservoir, and (3) the increase in reservoir pressure. Repressuring of an undersaturated oil reservoir by 1000 psi will require an amount of gas, measured at reservoir pressure, equivalent to about 1 to 2 percent of the pore space. During the remaining repressuring periods more gas will be required, because the gas previously injected will be compressed.

Compressing the fluid in a reservoir containing free gas liberated as the reservoir pressure was reduced below the saturation pressure of the oil will require the injection of more gas than if the reservoir was saturated with liquid. The injection gas necessary to compress the fluid may occupy as much as 4 to 8 percent of the reservoir pore volume for the first repressuring operation. Because the gas saturation is low during the first production operation (perhaps not over 10 percent) the liberated gas will remain in the pore space where it was liberated. This liberated gas in the reservoir will redissolve in the oil during the period of repressuring. Thus, the greatest factor influencing the amount of gas required to restore the reservoir pressure is the volume of gas dissolving in the oil.

The amount of makeup gas required, based upon 1 barrel of produced stock-tank oil, will vary for different reservoirs and will be influenced by: (1) Reservoir pressure and temperature, (2) the gravity of the oil, (3) the amount of solution gas, (4) the formation volume factor of the initial reservoir oil, and (5) the difference between the initial reservoir pressure and the saturation pressure of the reservoir oil. The influence of these factors can be calculated with

but not at the edge of the field, are

into an oil reservoir is the displace-

a fair degree of accuracy. Other factors, which are of less significance but cannot be calculated with a high degree of accuracy, are the quantity of gas that will dissolve in the reservoir oil (undersaturated with gas initially) and the amount of vaporization of the immobile reservoir oil that will occur as gas is cycled through the reservoir. Little gas will dissolve in undersaturated oil of low API gravity, and there will be little vaporization of the oil. The quantity of injection gas that will dissolve in medium gravity oils will be nearly offset by vaporization of the oil.

The passage of high-pressure gas through a reservoir containing an unsaturated oil of high API gravity creates a unique condition in which virtually all of the oil in a flow path is displaced away from an injection well by the wave front of the injected gas. Slobod and Koch[2] state: "Recoveries in type M displacements, enriched gas miscible at the front with reservoir fluid, are not sensitive to the relative permeability characteristics of the porous medium and approaches 100 percent of the oil in place of the area contacted." A high gravity oil is necessary for the type M displacement. Under these conditions, only a small part of the reservoir oil is contacted by the injected gas at any one time. Thus, little gas will be dissolved in the oil, compared with the total volume required for makeup gas, and there will be little vaporization of the oil by the injected gas.

Calculations were made to determine approximately how much makeup gas would be required to displace oil, at the initial reservoir pressure, from some hypothetical reservoirs. The assumed reservoir pressures, types of oil, solution-gas contents of oil, formation-volume factors of oil, and saturation pressures of reservoir oil were varied widely. The assumed conditions and results of the calculation are given in Table 1.

The values for makeup gas in Table 1 were calculated for a batch-type cycling project in which the initial reservoir pressure is restored by injecting gas. Each approximate volume of makeup gas was determined by calculating the volume of atmospheric-pressure gas required to replace the volume of reservoir oil produced and subtracting from this gas volume the produced solution gas. The first hypothetical reservoir in Table 1 will serve as an example. In this reservoir 1 barrel of stock-tank oil is equivalent in volume to 3 barrels (16.8 cubic feet) of oil in the reservoir (formation volume factor = 3). The volume of atmospheric pressure gas necessary to fill 16.8 cubic feet of space at 4000 psia and 180° F. is approximately 4000 cubic feet. The solution gas for 1 barrel of stock-tank oil is given as 3200 cubic feet. Therefore, the amount of makeup gas required is 800 cubic feet per barrel (4000 minus 3200).

The volume of makeup gas needed is not influenced by the amount of free gas produced because it is reinjected into the reservoir and no consideration was given to the amount of gas used in operating the compressor station. However, this volume of gas would be more than offset by another factor. The total makeup gas needed for a multireservoir unit is the sum of the calculated volumes for each reservoir; but, one or more of the reservoirs will not be completely repressured at any time. Thus, the values shown in Table 1 for makeup gas should be reduced slightly when predicting the volume of makeup gas needed.

TABLE 1
Calculated Volumes of Makeup Gas Required During Batch-Type Gas Cycling for Some Hypothetical Reservoirs

Reservoir Pressure, psia	Reservoir Temp., °F.	Gravity of Stock-Tank Oil, °API	Saturation Pressure of Oil, psia	Solution Gas in Oil[1]	Formation Volume Factor for Oil	Makeup Gas Required[2]
4000	180	50	4000	3200	3.00	800
4000	180	50	2000	1000	1.70	1300
4000	180	50	100	100	1.20	1500
4000	180	35	4000	1500	1.80	1000
4000	180	35	2000	600	1.40	1300
4000	180	35	100	70	1.10	1400
4000	180	20	4000	500	1.30	1200
4000	180	20	2000	250	1.20	1300
4000	180	20	100	20	1.10	1400
2000	120	50	2000	1000	1.60	400
2000	120	50	1000	600	1.40	600
2000	120	50	100	100	1.10	830
2000	120	35	2000	600	1.30	500
2000	120	35	1000	350	1.20	700
2000	120	35	100	70	1.08	860
2000	120	20	2000	250	1.12	700
2000	120	20	1000	125	1.10	800
2000	120	20	100	20	1.06	900
1000	90	50	1000	500	1.35	100
1000	90	50	100	100	1.07	350
1000	90	35	1000	300	1.20	250
1000	90	35	100	70	1.05	370
1000	90	20	1000	100	1.05	320
1000	90	20	100	20	1.04	420

[1] Cubic feet of separator gas, measured at 14.7 psia and 60° F., per barrel of stock-tank oil.
[2] Cubic feet of gas measured at 14.7 psia and 60° F., per barrel of produced stock-tank oil.

Secondary Recovery. In primary-production gas-cycling operations, both conventional and batch-type, the wells located high on the structure are used for gas injection. This location is chosen to take advantage of drainage. In the use of batch-gas cycling for secondary-recovery operations in anticlinal reservoirs, the advantage due to oil-gravity drainage may be more than offset by other factors. During repressuring the injected gas carries much oil, both in the liquid and gaseous phases, away from the injection well.

If gas is injected into centrally located wells, a large portion of the oil will migrate past the outer wells if they are not on the extreme edge of the field (see the chapter, "Distribution of Oil in Semidepleted Oil Reservoirs After Repressuring With Gas" in Reference 1), and little of this oil will be recovered during cycling operations. If the outer wells are used for gas injection, much of the oil inside of the injection wells will be carried toward the producing wells centrally located in the field. Thus, more oil will be recovered by injection gas into the outer wells.

Production data from a semidepleted oil reservoir used for gas storage and laboratory data,[1] indicate that about two-thirds as much oil may be recovered during gas-storage operations as was recovered during primary production. After only two years of gas-storage operations, over 200,000 barrels of oil was produced from the reservoir as compared with about 825,000 barrels of oil produced during primary production. The reference field was completed with six wells. Two centrally located wells are used to inject gas into the reservoir. The other four wells, located nearer

familiarizing themselves with several

but not at the edge of the field, are producing wells. It was calculated that the oil recovery during gas-storage operations would have been about 1.6 times that obtained during primary production if the choice of injection and producing wells had been reversed.

In many deep reservoirs water flooding for secondary recovery may not be practical. However, large quantities of oil may be recovered from many deep reservoirs by repressuring and cycling with gas. As the reservoir pressure increases with gas injection, gas will be dissolved in the oil. There will be a swelling of the oil and a corresponding increase in the liquid saturation in the reservoir, which will permit more oil to be swept by gas to the producing wells than would be possible without repressuring. Additional oil recovery may also be expected as a result of vaporization of medium- and high-gravity oils in contact with injected gas and its subsequent recovery from the produced and processed gas.

This type of secondary recovery may be economically practicable, even though the reservoir is not operated for gas storage; however, gas-storage operations make batch-type gas-cycling operations possible when only one reservoir is considered. When two partly depleted oil reservoirs are close together, the batch-gas cycling can be practical, even though the reservoirs are not used for gas-storage purposes. After one of the reservoirs has been completely repressured and the other partly repressured, the procedure outlined previously can be followed. After the recovery of oil by this procedure is completed, the reservoirs may be used for gas storage alone. If this is not desirable, most of the gas in the reservoirs can be recovered by conventional producing methods.

Secondary recovery during high-pressure batch-gas cycling might be highly efficient in many of the deep oil reservoirs containing high-gravity oil. Previous work[3] indicates that low oil recovery is obtained by expansion-type primary production. Because so much stock-tank oil, percentagewise, is left in this type of reservoir at the end of primary production, the oil recovered might be two to three times as great as that previously produced.

Gas-storage operations in partly depleted oil reservoirs are proving to be highly successful, both for gas storage and additional oil recovery.[4,5] Gas-storage operations may have application for increasing oil recovery in newly discovered oil reservoirs in connection with batch-gas cycling. In a system with two or more reservoirs in a unit, the demand gas would be supplied from the producing wells of the reservoir or reservoirs currently being produced. If this source of gas would not meet the demand, the additional gas would be obtained from the reservoir or reservoirs currently being repressured with gas. This additional gas should be obtained from wells used for gas injection.

About the Author

ALTON B. COOK, research petroleum engineer at the Bureau of Mines Petroleum Experiment Station, Bartlesville, joined the station in 1935 after graduating from the University of Oklahoma. His research work has been directed toward devising new methods, or improving the present accepted methods, of calculating the benefits of pressure maintenance. His simplified material-balance equations, published in 1943, and his pioneering work on predicting reservoir performance of highly volatile type oil reservoirs, published in 1951, are well known by the reservoir engineering profession.

Reservoir Performance. In most gas-cycling projects in operation today, the reservoir pressure is at or below the initial saturation pressure of the reservoir oil. Under these conditions, a substantial part of the oil will adhere to the solid surfaces in the reservoir and will remain in the reservoir as immobile oil. However, part of this immobile oil will be produced as products of vaporization carried to the producing wells by the dry injection gas.

The initial result of injecting gas into an oil reservoir is the displacement of oil away from the injection well. However, the oil saturation in the area immediately surrounding the wellbore does not rapidly approach a minimum as in water flooding. Instead, both the oil and gas will flow simultaneously. As gas injection continues, the oil saturation near an injection well will be reduced to a minimum for liquid flow. The areal extent of the reservoir surrounding the injection well in which liquid will not flow becomes greater as additional gas is injected.

Laboratory experiments of Bureau of Mines and data obtained by others[1,2,6,7,8] indicate that the gas and oil in any specified minute part of a reservoir coexist at conditions closely approaching phase equilibrium. As injected gas contacts reservoir oil, vaporization of some of the oil occurs, and some gas may dissolve into the oil to establish equilibrium. The first gas injected into a reservoir travels only a short distance before it is enriched with products of vaporization to the maximum possible for that particular composition of the reservoir oil at the prevailing reservoir pressure and temperature. However, after a short period of gas injection, oil near the injection well will have lost most of its gas-soluble components. Thus, as injection is continued, gas will travel farther and farther from the injection well before vaporization of oil will result in maximum enrichment of the gas.

The portion of the immobile oil that can be vaporized during a gas-cycling project and the rate of vaporization depend largely upon the type of the oil and the pressure and temperature during gas cycling. For example, cycling gas at 1000 psi through a reservoir containing a 20° API gravity oil at 100° F. would result in little vaporization. However, more than 75 percent of the immobile oil in the flow path of a reservoir containing a 50° API oil at 250° F. might be vaporized when cycling at a pressure of 5000 psi. An experiment conducted at the Bureau of Mines laboratories with a sand-packed tube as a laboratory reservoir simulating gas cycling resulted in about 50 percent of the immobile oil being vaporized. This experiment was conducted by cycling gas at a pressure of 2000 psi and a temperature of 132° F. The

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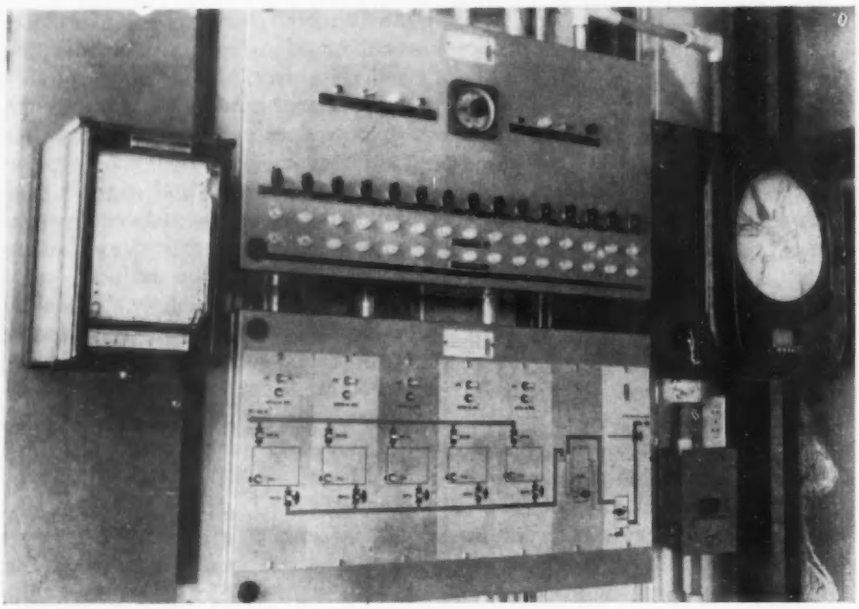


The intricacies of automation equipment still require the skill of the specialist. This detail is of little importance to the field engineer whose interest is primarily in results.

Simplifying Automatic Lease Control Systems

Automation is here to stay . . . and grow. Field personnel who once left problems and design to the experts now find a need for a general knowledge of the subject themselves. Here it is in simple terms.

By JACK W. ALLEN, Vinson Supply Company
and HUGH A. SAYE, Jr., Control Specialty Corporation
Houston

WITH EVER INCREASING attention being drawn to automatic lease control, many petroleum and mechanical engineers at the district level in the field are finding themselves involved in some phase of lease automation. Pilot installations have been designed in some instances by specialists, but as automatic leases become more common, the general design decisions will have to be made by present field engineers.

This article is directed to production personnel who anticipate future responsibilities along this line. It will aid those interested in some of the basic design considerations and in familiarizing themselves with several of the individual components which they might encounter should they become involved in an automatic lease project.

Although the field engineer may want to call in specialists to work out the details of a proposed automatic lease system, he will save a great deal of time by studying his operating problems in the light of the general information outlined in this article. Knowing what basic systems and equipment he prefers, he can utilize the services of a specialist more effectively.

There are a number of basic units or "building blocks" which may constitute a lease control system, but under given conditions, only a few will fit the control and economic requirements. In order to arrive at a final design, the engineer must be familiar with the application and operation of available equipment and be able to visualize how it can be incorporated in a system.

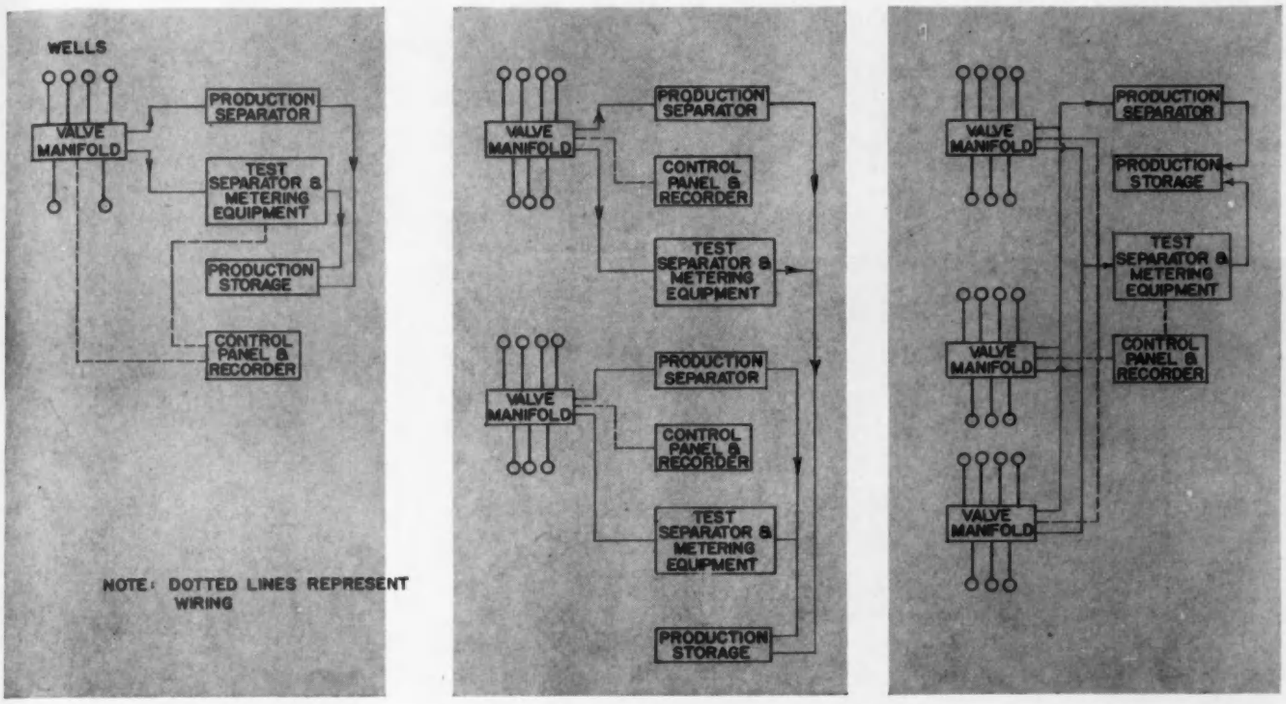
The complete lease control system may be made up of automatic well test and flow control, automatic tank switching and/or automatic custody transfer. We shall consider here these "building blocks" which make up automatic lease systems, treating them independently.

1. AUTOMATIC WELL TESTING AND FLOW CONTROL— BASIC SYSTEMS

The function of an automatic well test system is to provide a means of automatically diverting individual wells through test equipment for a predetermined test period, and of recording test data automatically. Automatic well flow control provides a means of shutting in wells individually or collectively for the purpose of regulating production or meeting emergency conditions. There are two basic systems of automatic well testing and flow control from which all others evolve: Centralized control and decentralized control.

A. Centralized control. Illustrated in block form in Figure 1A, it is usually employed on leases involving a moderate number of wells, where it is practical to lay an individual flow line from each well back to the separator station and tank battery. All wells are brought in to one header at the battery. The control panel and test equipment recorders are located at the battery. The centralized system has the advantage of central control and a central point for maintenance.

B. Decentralized control. See Figure 1B. Large leases do not lend themselves easily to the use of centralized control, due to the great expense involved in laying individual flow lines from the wells to a central location. Instead, several separate test stations can be set up over the lease. At each



A—Centralized Control B—Decentralized Control C—Combination Centralized-Decentralized

FIGURE 1—Centralized control and decentralized control are the two basic systems of automatic well testing and flow control from which all others evolve.

test station is located a production separator, test separator with appropriate metering equipment, a control panel and header valves controlling the flow of production from the wells in the area surrounding the test station. The number of test stations is determined by economic considerations by balancing the cost of test stations with the cost of installing flow lines. The total production from all wells at each station flows through a trunk line to central storage facilities. In event of emergency conditions, such as high level in production separator, power failure, or gas supply failure, the wells associated with the particular test station are shut in independently of the other test stations.

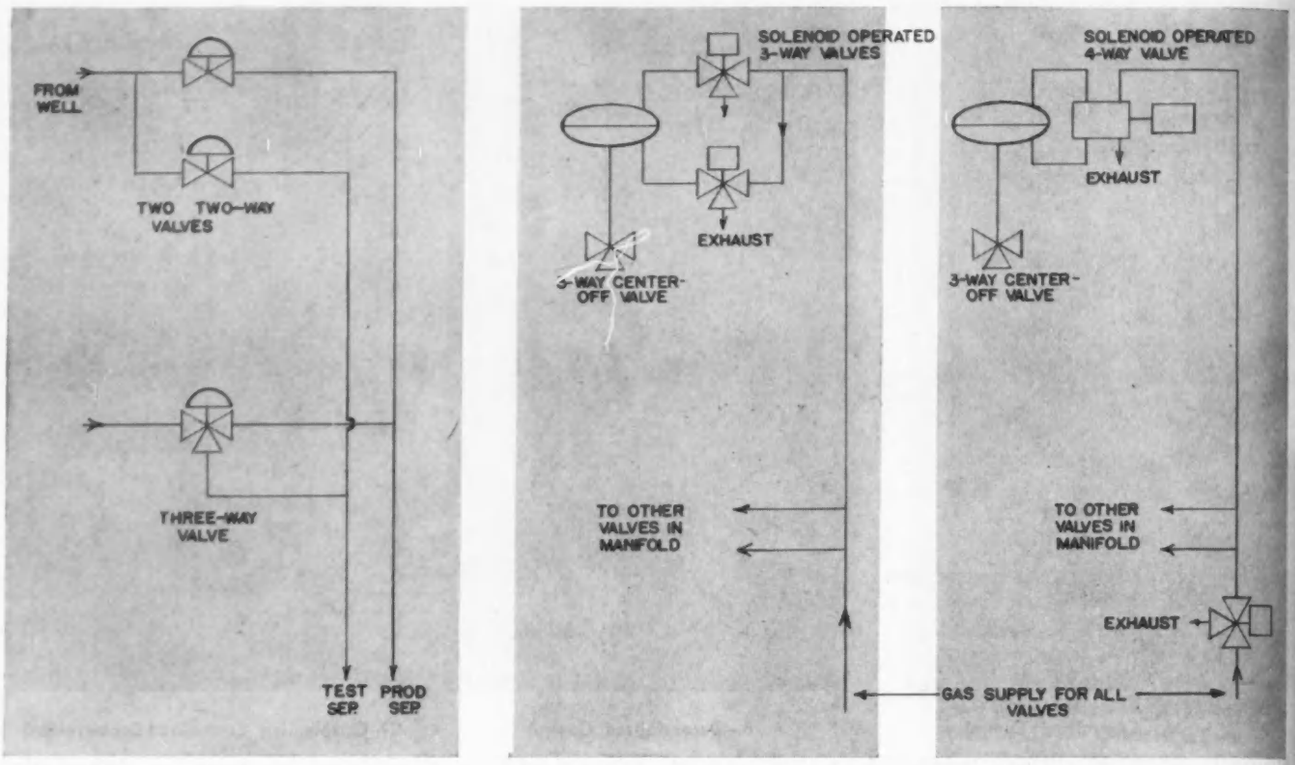
C. Combination centralized—Decentralized control. See Figure 1C. Instead of installing a test separator at each test station, one test separator (with oil, water and gas metering equipment) can be used to test all wells. The test manifold at each station is piped back to a central location where the test separator is located. The control panel can be located at the central location or there can be individual control panels at the test stations. The centrally located panel requires more wiring, but permits more flexibility in the control system. Depending upon the distances involved, it may be considerably less expensive to use this method rather than the straight decentralized system.

II. AUTOMATIC WELL TESTING AND FLOW CONTROL BASIC EQUIPMENT

A. Selection of valve arrangement. 1. Valves must be chosen to divert wells selectively to test, to control production (for stop-cocking operation) where required, and to enable shut-in of wells simultaneously in emergency. The three types of valve bodies used for this service are two-way, three-way and four-way, center off. Figure 2A illustrates how two two-way valves or one three-way valve can be used to divert oil to the production or test separator. The three-way, center off valve is piped the same way as a conventional three-way valve, but it requires a different control arrangement.

Valves may be operated electrically, hydraulically or pneumatically. Most popular are electro-hydraulic and electro-pneumatic. The former type operator consists of a small electrically driven pump which provides hydraulic pressure to operate a piston, which in turn positions the valve stem. The more conventional electro-pneumatic operation employs a diaphragm valve, powered by gas or air, and piloted by a three-way electric solenoid valve. Regardless of the type operator, the control systems described would be substantially the same.

Figure 2 shows two possible ways of controlling the operation of a three-way, center off diaphragm valve. This type valve is designed to allow the opening of either of the two ports (test or production) in such a manner that one port will always be closed when the other is open or that both ports may be closed if so required. The valve action is such that by pressuring either side of the diaphragm, either one of the two ports can be opened. With no pressure on either side of the diaphragm, both ports will be closed. This action may be effected in two ways: Figure 2B shows two three-way solenoid pilot valves controlling the air (or gas) supply to the diaphragm. The main valve action depends upon which of the two solenoid valves is energized. If neither is energized, the main valve stays closed. This requires separate control circuits to each solenoid. Figure 2C shows one four-way solenoid pilot valve controlling the main valve action. The solenoid valve has only two positions (valve energized or not energized), which means that the main valve is either diverted to flow or test, but can not be shut off. A separate pilot valve in the main air supply line is used to remove power air from all valves si-



A—Valve Manifold Arrangements

B—Pilot Arrangements for 3-Way, 3-Position Valve Using Two 3-Way Solenoids

C—Pilot Arrangement for 3-Way, 3-Position Valve Using One 4-Way Solenoid

Figure 2—Valves and valve arrangement are an important part of the basic equipment for automatic well testing and flow control.

multaneously in case it is desired to shut in all wells. This system requires only one control circuit per diverting valve, but does not permit individual shut-in of wells.

Selection of valves for this diverting service is influenced by several factors, the majority of which are shown in Table 1.

2. Shutting in wells from the header is accomplished in one of three ways, depending upon the conditions at the lease:

a. If high pressure flow lines are installed between the well and the header at the tank battery, wells can be shut in directly by closing the header valves.

b. If the flow lines are not designed to withstand well shut-in pressure, a "high-low" pilot can be used in conjunction with a diaphragm valve located at the well head. When the valve at the header is closed, pressure starts to build up in the flow line, when it reaches a predetermined point, the pilot causes the well valve to close. Likewise, in case the pressure drops below a set point, due to flow line break, the pilot causes the well valve to close.

c. If the wells are being pumped instead of flowed a pressure switch can be installed at the well to sense pressure build up due to the header valve being closed. This pressure switch is used to shut down the pump motor or engine.

B. Test equipment. No attempt will be made here to discuss details of test separators or meters. Two basic types of oil and water meters are commonly used; dump type meters and positive displacement meters. Either can be equipped with electric counting switches to provide the necessary electrical pulses for recording of test data. Integrating gas flow meters, either positive displacement (for low pressures) or orifice type, are used to determine total gas produced during test, and to provide an electrical pulse for each unit of gas.

C. Control panels. The purpose of the control panel is to actuate the manifold valves in sequence, so as to divert production from one well at a time through the test equipment. Basically, the panel provides a means of:

1. Predetermining the length of test period or periods.

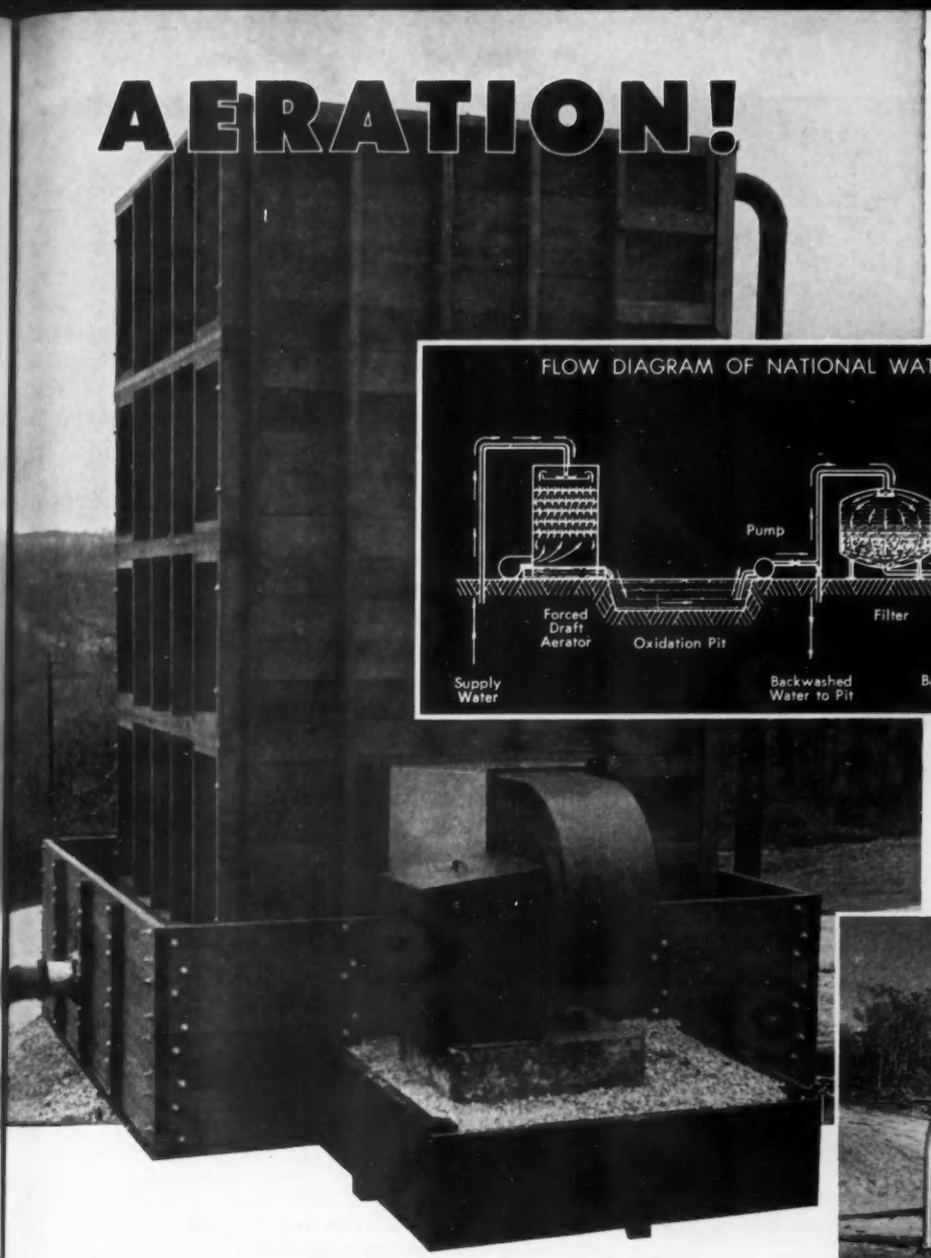
2. Manually initiating and termi-

TABLE 1
Selection of Valves for Automatic Well Test and Flow Control

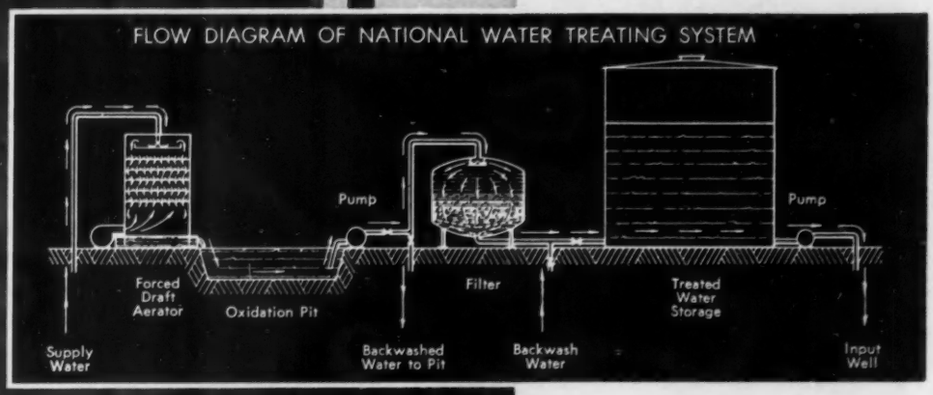
Required Function or Operating Condition	Type Valve Recommended at Header			
	3-Way 2-Position	Two 2-Way	3-Way* Center-off	3-Way† Center-off
Wells shut-in individually at header for flow control (stop cocking)	No	Yes	No	Yes
Simultaneous shut-in of all wells at header (emergency condition)	See Note	Yes	Yes	Yes
Valves shut-in production in case of power failure	No	Yes	No	Yes
Max. operating pressure—Standard makes pneumatic valves —Size 2" (reduced port)	3,000 psi	10,000 psi	3,000 psi	3,000 psi
Max. operating pressure—Standard makes electrically operated—Size 2" (reduced port)	225 psi	6,000 psi	Not Avail.	Not Avail.
Electric or pneumatic operared plug valves	Limited Only by Plug Valve Design			

Note: Since this valve either diverts to production or test, it does not shut-in production. For this purpose a two way valve can be installed between the production header and the separator.
* Controlled by 4-way solenoid pilot.
† Controlled by two 3-way solenoid pilots.

AERATION!



National Aerator for treating supply water or disposal water in open water system.



Two National Aerators in series with water supply well located north of Tulsa, Oklahoma.

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Submerged Aerators are also manufactured by National as are complete closed and open water systems.

Our Engineering Department welcomes inquiries concerning your water disposal problems.

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instead of flowed a pressure switch

† Controlled by two 3-way solenoid pilots.

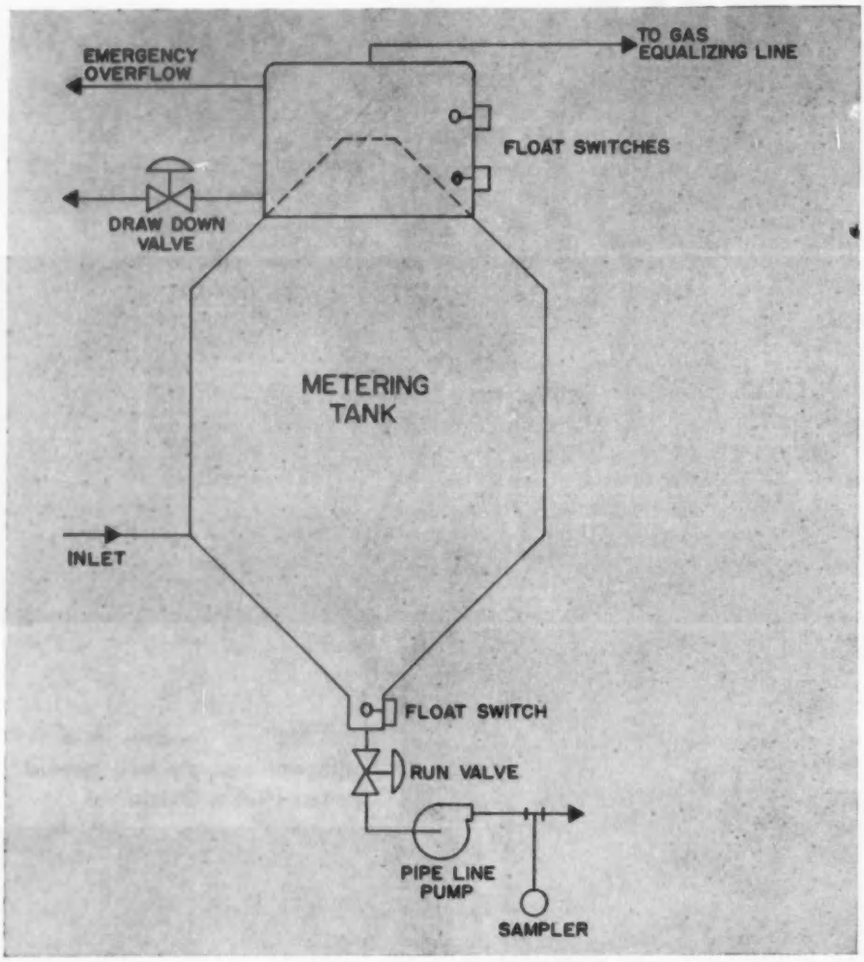

FIGURE 3—This diagram illustrates a relatively new system of tank volume measurement which has considerable merit. An adequate description of its operation is included in the text.

nating tests of well, independent of the test period timer.

3. Controlling the programming of well flow, where required.

4. Shutting proper valves automatically in case of emergency conditions, such as high level in test separator or production separator.

5. Receiving electrical information from test equipment and transmitting it to test data recorder, providing a means of identifying the well to which the test data corresponds.

The panel must be designed with components which will withstand long, constant use under the existing field conditions of climate and corrosive atmosphere, with a minimum of maintenance. Plug-in hermetically sealed components are sometimes advisable, particularly where relatively inexperienced personnel will be servicing the equipment.

D. Recording of test data. 1. Strip Chart Recorder. A multi-pen type strip chart operations recorder can be used to record test data. Separate pens are employed to record each item of data as follows:

a. One pen makes a number of marks corresponding to the code number of the well on test.

b. One pen is actuated during the test period. The length of line drawn by the pen provides a record of the length of test, as the chart moves at a known fixed rate.

c. One pen makes a mark for each unit of production of oil, as determined by the closures of the counting switch on the oil meter.

d. Ditto for water and gas.

2. Data Print-Out in Digital Form.

The test data may be reduced to digital form and printed out at the end of each test. Recorded are:

Well Number
Length of Test Period
Oil Produced
Water Produced
Gas Produced
Date, Time of Test Completion
Name of Lease

E. Measurement of Properties of Oil.

A. Sampling.

Samples can be taken downstream from the test separator. In some cases, a composite sample of all tests for a period of time is considered satisfactory. However, it is often more satisfactory to be able to provide a sample from each well test. Equipment is available which will take a sample proportional to flow, and store it in an airtight container.

B. Recording Instruments.

Instruments are available which will enable continuous measurement and recording of BS & W and of gravity by electric and electro-pneumatic means.

III. AUTOMATIC TANK SWITCHING

Automatic tank switching is the oldest and simplest phase of lease automation. It has been used in many areas for several years. For this reason, no detailed discussion of tank switching will be presented. Recent improvements in tank valves and control panels include:

A. Rapid operation of valves (1½ seconds to stroke).

B. Instantaneous switching by panel.

C. Graphic representation of tanks and separator on front panel, with lights to show condition of valves.

D. Hermetically sealed, plug-in components.

E. Reliable pneumatic tank switchers, for use where no electric power is available.

IV. AUTOMATIC CUSTODY TRANSFER

Despite the improvements in tank switching, automatic custody transfer is the overshadowing development. The current trend is toward automatic transfer of production from the lease to the pipe line.

There are three basic systems of automatic custody transfer: Measurement of volume in tanks, by positive displacement meters and by weight. The most popular systems to date have utilized volume metering in tanks, probably because it is the least deviation from the conventional method of measurement. The metering tank volume is fixed by two weirs, located at top and bottom of the tank.

Since space does not permit examination of the various systems, we

Continued on Page 236

NATIONAL TANK COMPANY
TULSA, OKLAHOMA

This top secret sketch of an inhabitant of the moon was furnished by a Baron Münchhausen, who is connected with the gaseous and fuelish phase of the earth satellite program. The Lunarman illustrated is undoubtedly an oil man, since the position of his head shows that he plays his cards close to his chest.

DON'T believe it...

until you see it yourself!

Anyone can gaze at the full moon, howl his head off and draw a looney picture. But, neither loud howling nor wild picture will mean much to a sensible observer.

We could yell our own heads off about *MARLO POLISHED ROD PACKING, and we could draw an amazing picture for you. And we could do both *honestly,* in broad daylight.

Yet, we'd rather that you'd see the *real thing.* We know that the impartial evidence of your own equipment, watched with your own careful eyes, will convince you that there is no moonshine in the MARLO story.

Try a set. Field records *prove* that MARLO has repeatedly outlasted ordinary packings 8 and 10 and more times. MARLO PACKING reduces rod wear, cuts "down time," does not harden or burn out during "pump off" and saves oil. This is a sane, accurate picture of the facts. But, don't believe it – UNTIL YOU SEE IT YOURSELF. *Then draw your own conclusions.*

*MARLO POLISHED ROD PACKINGS are manufactured by THE MARLO COMPANY, INC., New York 13, N.Y.

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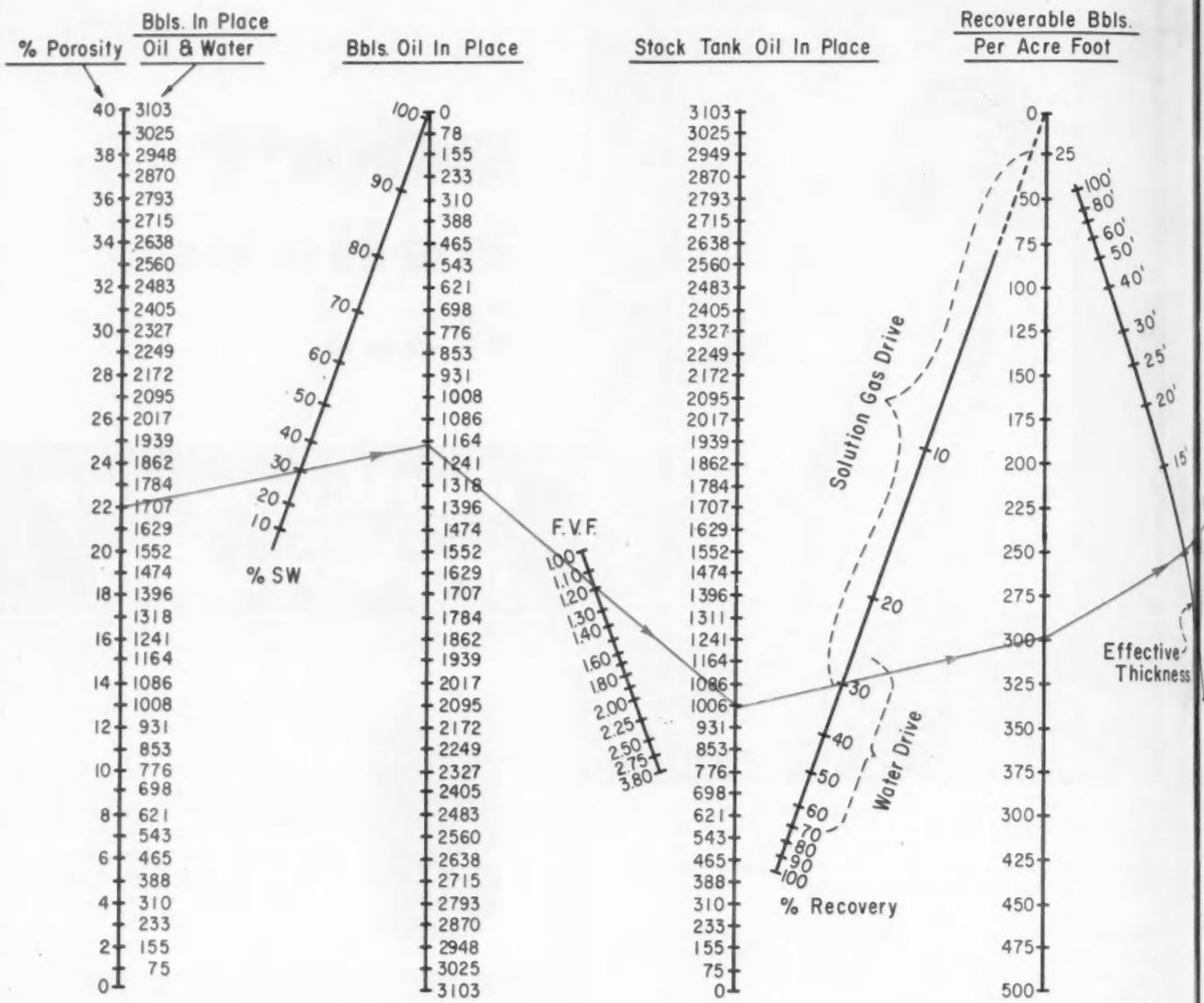
strip chart operations recorder can be

Name of Lease

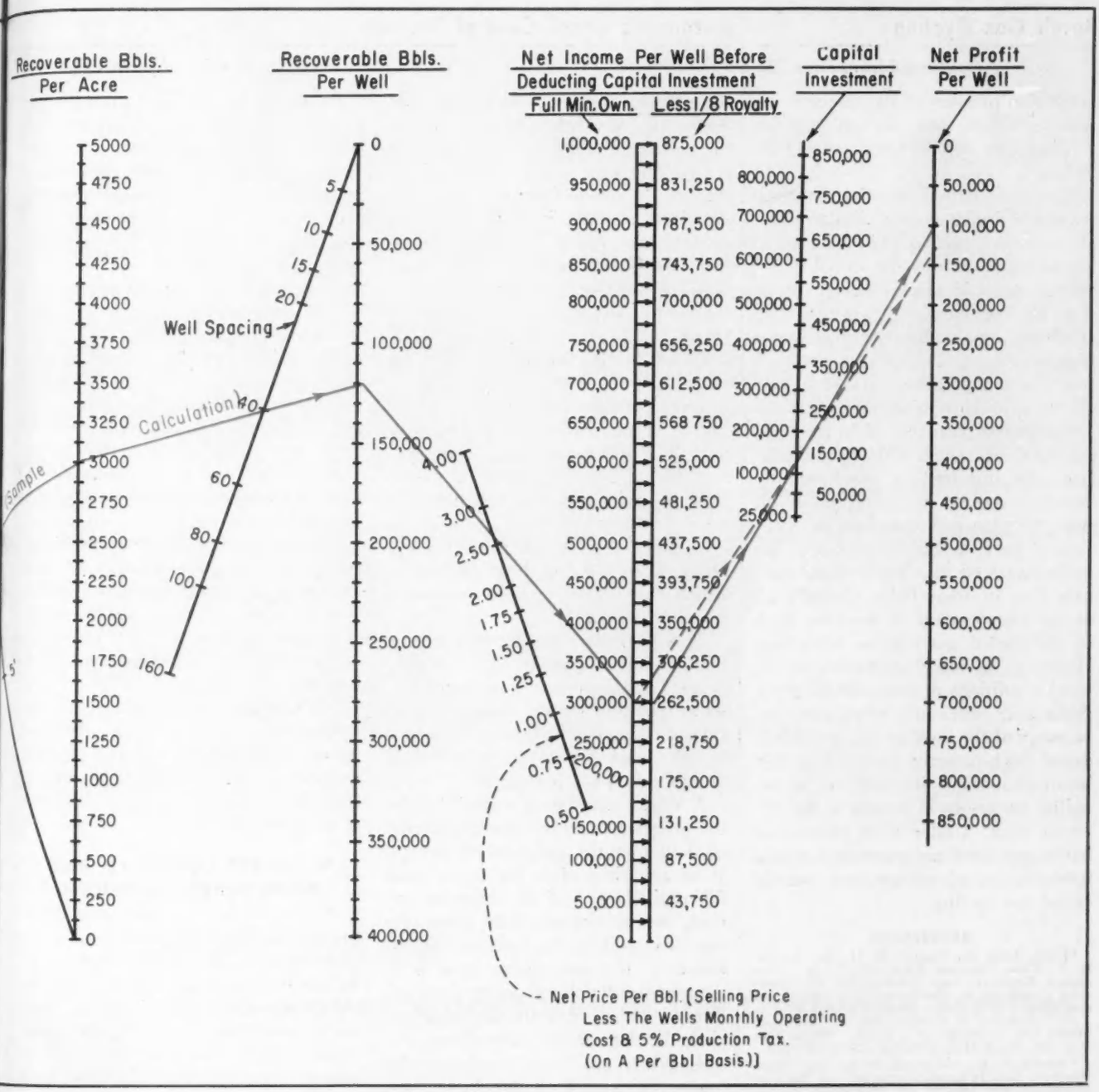
Continued on Page 236



Note:
Accuracy requirements limit this nomograph to the lower recovery ranges. If the results fall off the nomograph, use ½ or ¼ actual thickness and multiply the end results accordingly.

A Quick Look at Your Production Economics

By G. G. TUBB, Magnolia Petroleum Company, Oklahoma City


Recoverable Bbls. Per Acre
Recoverable Bbls. Per Well
Net Income Per Well Before Deducting Capital Investment
Full Min. Own.
Less 1/8 Royalty
Capital Investment
Net Profit Per Well
Well Spacing
Calculation
Sample
Net Price Per Bbl. (Selling Price Less The Wells Monthly Operating Cost & 5% Production Tax. (On A Per Bbl Basis.))

In the course of his work, the development geologist or engineer is daily required to make recommendations based on the potential profit or loss which may be expected from drilling a well. In his evaluation of the problem, he must make use of mathematical formulas involving reservoir data. Because the data upon which these calculations are based are not of a precise nature, nomographs can be used to obtain the desired results. The results which may be derived simply and quickly from this Nomograph for Oil Production Economics are normally within the range of accuracy of the data involved.

ACKNOWLEDGMENT

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Batch Gas Cycling

Continued from Page 227

saturation pressure of the reservoir oil was 1,900 psi, and the oil had an equivalent stock-tank gravity of 44° API.

Results of experiments by other researchers[2] indicate good displacement efficiency for cycling dry gas in some reservoirs at or near the initial reservoir pressure. However, special conditions are necessary to obtain this high efficiency. Favorable conditions are high-gravity oil, a deep reservoir, high reservoir temperature, and reservoir oil with its saturation pressure considerably less than the virgin reservoir pressure. This high efficiency results from the injected dry gas becoming enriched due to vaporization of oil near the gas-wave front and the solution of part of this rich gas into the undersaturated oil. Their data indicate that in some fields virtually all of the reservoir oil in the flow path of the cycled gas can be recovered. However, in many reservoirs, under ideal conditions of reservoir-oil properties and reservoir pressure, the recovery of the in-place oil by conventional high-pressure gas cycling will be small if there are extreme permeability variations in streaks of the reservoir rock. Under such conditions, batch gas cycling probably would have decided advantages over conventional gas cycling.

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ACKNOWLEDGMENT

This article was published in the May, 1957, issue of the AIME publication *Journal of Petroleum Technology.*

Automatic Lease Control Systems

Continued from Page 232

have chosen to present as an example a relatively new system of tank volume measurement which has considerable merit. The system has been used by Phillips Petroleum Company, and was described recently in a paper delivered to the AIEE in Kansas City, Mo., by G. G. Hebard, assistant to chief production engineer, Phillips Petroleum Company, Bartlesville, Okla.

Figure 3 illustrates the metering tank used in the Phillips custody transfer system. The tank was a 45-degree truncated cone top and bottom. The top cone, which comprises the top weir, is under a dome equipped with two float switches. The operation is as follows:

1. Merchantable oil enters tank, filling it to the top float switch, at which time fill valve closes and transfer pump stops.

2. A program timer set by the pipe line determines times at which oil may be run, and a predetermining counter set at the approximate allowable overrides the timer. The counter will shut in the lease when the number of dumps called for is reached.

3. When transfer is called for by the program timer, a degassing period of 0-30 minutes (adjustable) begins. If at any time after the meter tank fills until the end of the degassing period, the oil volume falls below the top float switch, the tank will be allowed to top out again. This is to guarantee full volume delivery at each dump. At the end of the degassing period, the draw-down valve opens.

4. When the level drops to the lower float switch in the dome comprising the draw down chamber, the run valve opens, the pipe line pump starts, and sampling begins.

5. When the level reaches the float switch above the run valve, the valve starts closing and will be fully closed when the level is somewhere below the run valve.

6. Sampling stops, the pipe line pump stops, and the fill valve opens again.

This system has insured accuracy because the volume run every time is the entire amount from the weir to the bottom valve, and no more or less. The advantage of this system, in addition to positive accuracy, is simplicity of controls and speed of operation.

In order to provide an accurate means of recording the number of runs and at the same time to record the temperature in order to correct volumes to 60 F., the temperature in the tank and the static head are recorded continuously on a strip chart recorder. The temperature at the time the tank was full can be easily seen on the chart.

A means of assuring that only merchantable oil enters the metering system is needed. An electronic instrument for detecting excessive water cut can be installed upstream from a surge tank which supplies the meter tank. When bad oil is detected, a three-way valve in the surge tank fill line automatically diverts production back through the treating facilities. Although there are a number of variations in automatic custody transfer systems, most of them are basically the same.

In addition to a means of measuring volume accurately (by one or more metering tanks or by positive displacement meters), they all have means of measuring specific gravity, temperature and BS & W automatic sampling is usually included as a part of the system.

V. SAFETY CONTROLS AND INTERLOCKED FUNCTIONS

Although the various basic components of the automatic lease have been treated individually, they must, in the final design, be compatible in operation and interlocked for complete control to meet emergency situations. The following conditions should cause shut in of all wells: high level in production separator or treater, loss of fire in heater treater of unavailable oil storage facilities. The following conditions should cause any well on automatic test to be diverted back into production: high level in test separator or treater, or loss of fire in test heater treater.

Depending upon operating policies of the particular lease involved, safety shut in of wells may also be required in case of loss of electric power or of gas or air pressure used to operate diaphragm valves. Remote control of lease shut in may also be desirable in offshore installations where it would be advisable to shut in wells in case of an impending hurricane.

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Water-Flood Prospects Need Analysis

The rapid growth of water-flooding during the last few years has stimulated the industry to exploit this method of operation to the maximum advantage. Many operators who formerly paid little attention to the secondary recovery possibilities of their properties now realize the importance of evaluating every prospect in their holdings.

By W. W. WILSON,
Continental Illinois National Bank and Trust Company, Chicago

SUCCESS IN WATER-FLOODING operations begins with the selection of prospects which have reasonable chances for profitable operation. A screening process should be used to select properties for flooding which have favorable reservoir conditions, and the development of those selected should be based on a thorough engineering analysis to seek out any indications of future operating problems in advance of their sudden appearance.

Even the best informed technologists differ in their opinions on what transpires in a reservoir during the flooding process, and there seems little hope that all of the fundamentals will be understood for some time to come. Individual reservoirs still perform differently from what can be calculated, and ultimate success or failure often cannot be predicted in advance. The limiting accuracy of any engineering study before flooding is started is often closely related to good luck and a happy choice of assumptions. Nevertheless, it is possible to make such a study which is within tolerable accuracy limitations with a minimum of basic data, and it is always highly advantageous to do so before major expenditures are committed.

Reservoir Data and Analysis. An analysis of a water flood prospect requires the meticulous sifting of practically every scrap of information concerning the reservoir, individual well completions and performance, and the over-all performance of the entire reservoir. The accuracy with which the analysis reflects the eventful flood performance is directly related to the availability of adequate data. It is also true that a fairly realistic forecast of flood performance can be made with only a small amount of basic data, provided that the primary performance history is sufficient for a detailed analysis.

Basic reservoir data, such as core analyses, well logs, fluid sample analyses, P. I. test results and bottom-hole pressures are highly desirable for any complete analysis, but usually only a limited amount of this information is available. Also, many of these factual data require interpretation in the light of reservoir performance before they can be used effectively. In the final analysis, the most important source of reservoir data is the normally kept record of oil, gas and water production during the primary life of the reservoir. Often what appears to be anomalous basic reservoir data can be explained or adjusted in accordance with reservoir performance, and most of the pieces will fall into place if all the data are analyzed objectively.

The first step in the analytical procedure should be a survey of the primary performance and the most obvious reservoir data, to determine qualitatively whether the prospect has water-flooding potentialities. Once this has been determined, a closer study can be made which should have as its objective the estimation of primary and secondary reserves and a forecast of future production rate. The final step is the preparation of an economic analysis to determine the investment required to flood the property, the future operating expense, annual rate of return, the eventual profit and such other economic factors as may be desired. Each of these steps will be discussed in this article.

Floodability. There are a number of basic factors which appear to control

This presentation outlines a procedure whereby a preliminary analysis can be made of a prospective water flood; first, to determine qualitatively the possibilities for success and second, to establish the potential value of the secondary reserves. The analysis can be made with a minimum amount of basic data and employs experience factors which are based on the results of many successful flooding operations.

Such an analysis should enable the average operator to screen out those prospects which have minimum possibilities for profitable operation. It should be emphasized however, that a study of this type is at best an approximation. It will not supplant more detailed engineering evaluations or the experience which can be gained from the operation of a pilot flood in the area considered.

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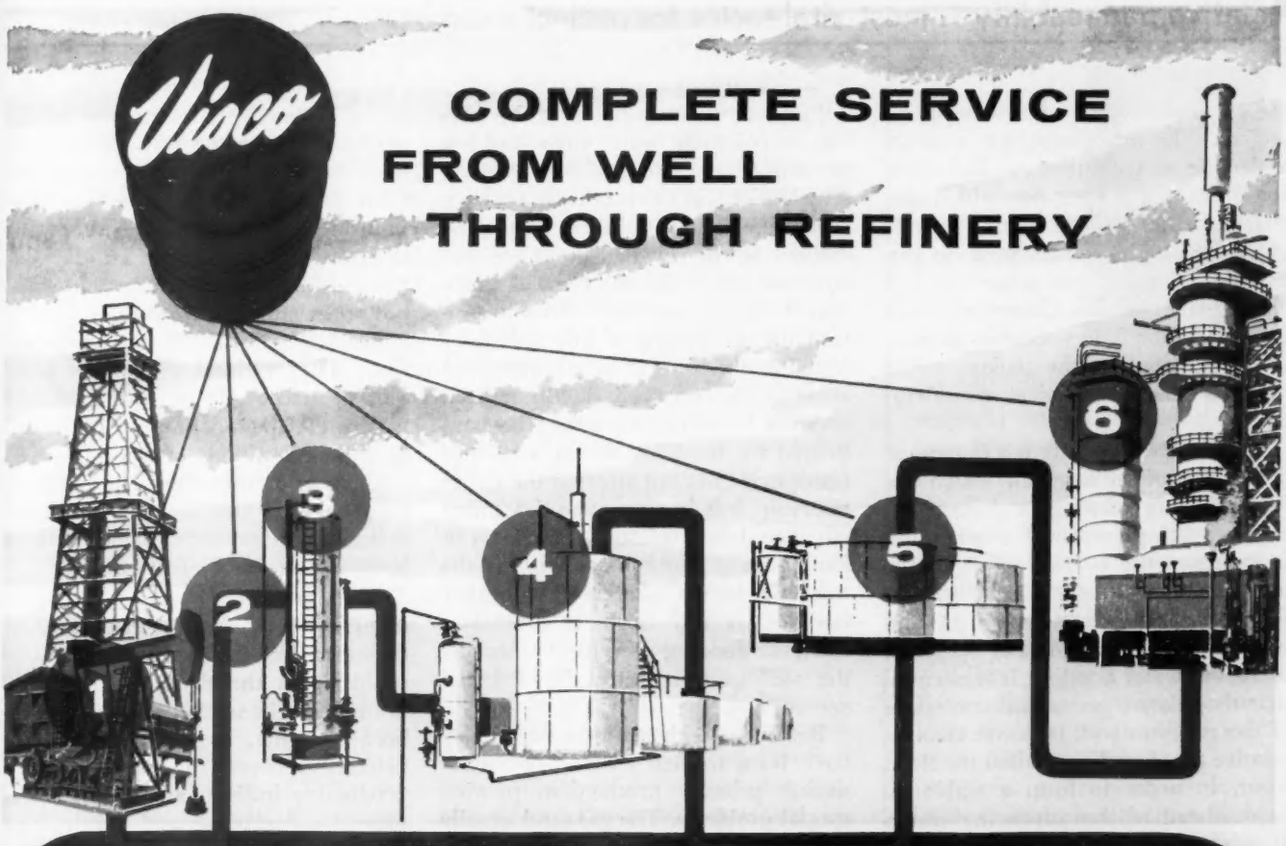

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Relative permeability is most vital factor for project's success . . .

the eventual success of a water-flood project. The most important appears to be the relative permeability characteristics of the reservoir, which dictates whether an oil bank will be formed, and the fluid saturation distribution during and after the oil displacement process. Other important factors include fluid viscosities, permeability distribution, the geology of the reservoir and mechanical considerations.

Relative permeability is a numerical description of the ease with which one fluid will move through a porous material in the presence of other fluids. It expresses the over-all effect of the texture and wetting characteristics of the reservoir rock, and the oil, gas and water saturation values. For optimum success in water flooding, it is essential that the relative permeability to water of the reservoir rock be lower than its relative permeability to oil at the flood front, in order to form a stable oil bank ahead of the advancing water. It is also essential that the oil saturation of the flooded section be reduced to an economically satisfactory low value by the displacing water.

Relative permeability to oil is more favorable when the oil saturation is high and the gas and water saturations are low; conversely, relative permeability to water is more favorable with low oil saturation and high gas or water saturations. The numerical values which relate to each condition differ with each reservoir and, indeed, in any reservoir the parameters probably vary within wide ranges for each substratum. Experience has indicated that where the oil saturation of the most permeable sections is less than about 35 percent the possibilities of water channeling are good. Successful water floods have been conducted in sands with connate water saturations in the range of 35-40 percent, but the possibilities usually will be poor where it is 45 percent or more.

Reservoirs which operated during their primary life by solution gas expansion are the best prospects for successful water flooding. Usually only about 20 percent or less of the original stock-tank oil content has been recovered, and, after shrinkage, the residual oil saturation generally is sufficiently high to assure a favorable relative permeability relationship.

Reservoirs which operated by partial or complete water drive are less attractive for water flooding, although some successful operations have been reported. Usually the most permeable sections in the invaded areas are watered-out, and the mechanical problem of segregating these zones to prevent the channeling of injected water is quite difficult. If any appreciable areas of the reservoir have not been invaded by water, they may be considered for flooding. Where a natural water drive has not affected the entire reservoir, it is important to determine whether there are faults, pinchouts or lenticularity conditions within the reservoir which prevented complete flushing. If any of these conditions exist, the flooding plan (and especially the well pattern) must be designed accordingly.

Reservoirs with gas-caps, which may have been formed either prior to or during primary production, provide special problems. The gas sand usually has a lower oil saturation than watered-out sand, and its relative permeability to water can be expected to be very high. As a result, it may channel water freely between wells. This limits the volume of water which will enter the pay sections, and creates an expensive water handling problem. In some cases the gas sections can be packed off in the injection wells, but if no barriers to vertical fluid movement are present, the use of packers may be unsuccessful. Again it is important to understand the geology of the reservoir in order to determine whether there is a mechanical solution to the problem.

Another important clue to floodability is the water production history of individual wells on the property. Any area where wells are producing measurable quantities of water should be studied carefully to determine the probable source of the water and the possibilities of future difficulties in the flooding program. Frequently, the situation may be traced to the presence of bottom water in the reservoir, with some of the wells having been drilled into a transitional zone. If such wells are used for injection service, it is reasonable to expect that the water bearing sections will accept a greatly disproportionate amount of the injected water, which then may be dispersed over a large area. Water also may enter the more permeable sections as a result of casing leaks or improper abandonments. Where water is allowed to head up in an idle well, the resulting hydrostatic pressure may be sufficient to backflow water through the productive part of the pay zone. The eventual solution of problems created by any of these conditions may limit the floodable area or the profitability of the operation. Localized areas of unusually high primary recovery may indicate that accidental flooding has occurred as a result of leaky wells or other causes.

The anomalous performance of individual wells during their primary operation may be indicative of future problems in the flood program. Abnormally tight sections or severe wellbore plugging, as indicated by poor primary recovery or unusually low productive indices, are suggestive of poor flood response and may require a modified development plan. Areas with unusually high GOR performance may be the result of localized gas caps or the presence of gas stringers which should be isolated in the injection wells. Correlation of unusual performance with well completion techniques may yield important data on the character of the reservoir.

The mechanical condition of all of the wells should be checked carefully to determine whether extensive remedial work is required for optimum flood performance. Records of well abandonments should receive careful attention to ascertain that the pay section was isolated before casing was pulled. Incomplete penetration of the section to be flooded may require the deepening of some wells, and other wells may need to be reworked to shut off gas zones or water productive sections.

The effect of any prior secondary recovery operations should be investigated. Ordinarily the short term use of vacuum or dispersed-gas injection will have little effect on the floodability of a reservoir, but this is by no means a certainty. Low pressure gas injection sometimes can be surprisingly effective (such as at Cook Ranch, in Shackelford County, Texas) and the present oil saturation can be reduced to a very low value. Any

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prior water injection should be investigated very thoroughly. In such cases a carefully coordinated coring program may be required, or the flood development may be started as a pilot in an unaffected area, with plans for cautious expansion into the uncertain areas at a later date.

Currently there is a great deal of controversy concerning the use of hydraulic fracturing before or during a flooding operation. Cases may be cited where naturally fractured reservoirs have exhibited poor flood performance, with expensive operating problems. Hydraulic fracturing has proven of great value, however, where producing wells have shown abnormally low total fluid production rates due to wellbore damage or blocking. It seems obvious that the size of the fracture job and the areal extent of the fractures are very important factors.

The viscosity of the reservoir oil has an important effect on the flood performance, especially if it is much in excess of 20 cp. For oils of lower viscosity, there seems to be little direct relationship between viscosity and recovery. Higher viscosity oils require more energy, and hence more water, to be displaced. Extremely viscous oil may be essentially bypassed by the water, with very low recovery efficiency. The limits of floodable oil viscosity have not yet been established. Laboratory work with flood pots has established that 1000 cp oils can be displaced by water, but there is no record of a successful flood where the oil viscosity was of this order of magnitude.

Reservoir Geology. The structural dip of the producing section is of importance only when it dictates the type of flood which must be used to control fluid movement. Under ordinary circumstances dips of 10 degrees or less are not critical in the choice between a peripheral or a pattern flood. By far the majority of floodable reservoirs are structural or stratigraphic traps where structure is not the determining factor in the selection of either a peripheral or a pattern flood.

Depth has a controlling effect on the pressure which may be applied. The hydrostatic pressure of fresh water is approximately 0.433 psi/ft of head; except for very shallow or tight reservoirs, hydrostatic pressure often provides adequate injection rates for economical flooding. One case has been reported where hydrostatic pressure was sufficient to cause natural fractures to open, resulting in severe problems of fluid control. Where additional surface pressure is required, there usually is some maximum BHP which can be used without causing fracturing or pressure-parting along weak bedding planes; this may be determined with a simple field test. Very few cases have been reported where the maximum safe BHP exceeds 1 psi/ft of depth. Where an adequate volume of water cannot be injected at the maximum safe pressure, the operator has the choice of using a larger number of closer-spaced injection wells, or operating for a longer period of time at reduced injection rates.

The type of porosity seems to be a very important factor. The majority of successful floods have been conducted in reservoirs with intergranular or oolitic porosity. Experience with vugular, cavernous, and dolomitization porosity is too meager for generalization. Fractured reservoirs, especially those wherein the fractures provide most of the porosity and permeability capacity, are a real problem. Where the fractures are relatively continuous over large areas, the injected water may displace only a minute fraction of the oil in place before serious water break-through occurs. Several cases have been reported where the operators were able to determine that the fractures were predominantly along one plane, and the flood was designed to cause fluid movement perpendicular to the fractures, with good results.

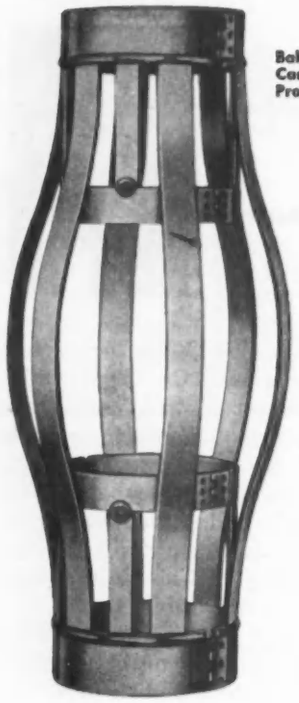
Lenticularity of the pay section can be both helpful and detrimental. Some degree of lenticularity is beneficial in that it limits vertical fluid movement. This is especially important where gas sand is present, or where wells are completed near bottom water. Some lenticularity also helps to maintain an essentially lateral fluid movement through the pay zones, thereby improving recovery efficiency. But where individual sand lenses are of very limited areal extent, severe losses resulting from trapping may occur, depending on the well spacing used. The degree of lenticularity in any reservoir can be inferred from zonation studies using logs and core data, but where there has been prior flooding, the continuity of individual lenses can be determined with good accuracy by tracing changes in fluid saturation as determined from uncontaminated cores.

Reserves. After the floodability of the reservoir has been determined or inferred, an estimate of the secondary reserves can be made. It should be emphasized that the procedures outlined herein, which require only limited data and the use of certain assumptions, are useful only for a preliminary evaluation and will not supplant more detailed engineering studies or the use of pilot floods. The analysis of floodability may have created such doubts concerning the success of the flood that it may be necessary to make several different reserve

About the Author

W. W. WILSON, petroleum engineer with Continental Illinois National Bank and Trust Company of Chicago, received his B.A. degree in geology at Pomona College, California, in 1940. He did graduate work in petroleum engineering at the University of California and at the University of Texas.

Wilson was first employed by Ryder-Scott Company, petroleum engineers of Bradford, Pa., from 1942-46. He spent the next year as research engineer with California Research Corporation at Whittier, Calif. From 1947-50 he taught petroleum engineering as assistant professor at the University of Texas. He joined Continental Oil Company at Ponca City, Okla. in 1950 as Senior Reservoir Engineer and subsequently became Chief Reservoir Engineer in the Houston office. Wilson has been in the Oil and Gas Department of the Continental Illinois National Bank and Trust Company for one year.



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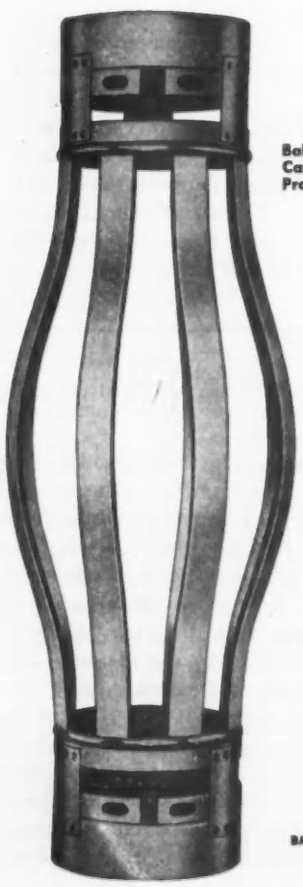

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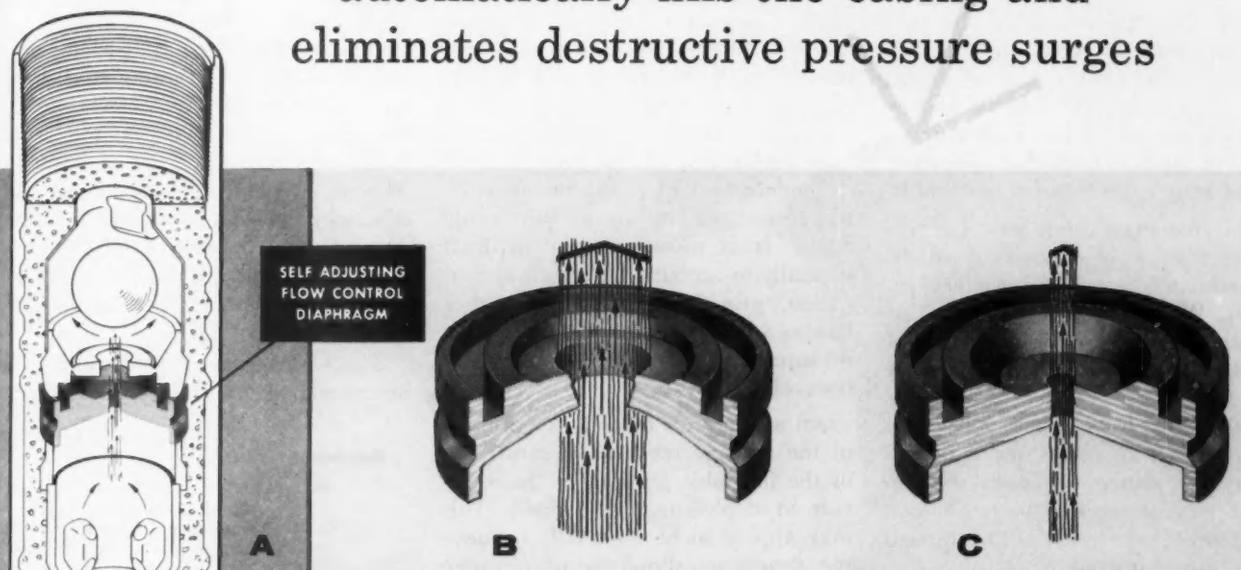

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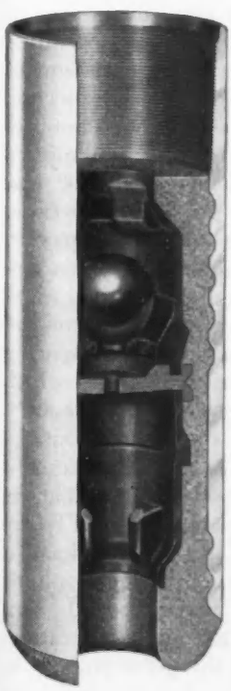

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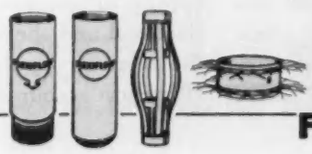

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estimates, each based on different assumptions of flood performance. This latter practice is to be recommended; if an analysis shows reasonably good economics under the most adverse assumptions which the preliminary study suggests, the project certainly is a good risk. Conversely, if it is determined that all of the breaks must be in favor of the operator to insure a profitable operation, one at least is forewarned of trouble.

One frequently hears that the secondary reserves of a property will be approximately equal to primary recovery. While this may be correct as a statistical average of a number of floods, it does not necessarily apply to any one project. Published records of water flood performance show such a wide range of recoveries as a percentage of primary recovery that no direct relationship can be established as a general rule which can be applied to any single operation.

The first step is to calculate the present average oil saturation of the reservoir. This can be done with reasonable accuracy using the following equation:

$$So = \frac{\beta(1 - Sw)}{\beta o} - \frac{P}{7758 \times \phi \times Ah}$$

where So = Present oil saturation, as decimal fraction of pore volume
Sw = Water saturation, as decimal fraction of pore volume
βo = Original reservoir volume factor
β = Present reservoir volume factor
P = Cumulative oil recovery, barrels
ϕ = Average porosity, as decimal fraction
A = Productive area of reservoir during primary operation
h = Weighted average contributing pay thickness for primary operations

Porosity and water saturation values are obtainable from cores, well log analyses or by anology with comparable reservoir. Formation volume factors may be estimated with acceptable accuracy from published correlation curves based on oil gravity, solution GOR and reservoir temperature. The relative accuracy of the data used in this equation may be verified by calculating the percentage of oil in place which has been recovered by primary operations; for solution gas drive reservoirs this seldom is more than 20-25 percent of the original oil content and often is less than 20 percent.

One must use the present average oil saturation value with considerable respect, because it may not be representative of the floodable part of the reservoir. The more permeable sections probably will have lower oil saturations than the average, and the ultimate success of the flood will be dependent to a great extent upon the recovery from the most permeable zones. It is also necessary at least mentally to account for edgewater invasion, gravity drainage and other factors which may have affected the oil saturation of localized parts of the reservoir.

An assumption then must be made of the average residual oil saturation of the floodable portions of the reservoir at depletion of the flood. This may appear to be essentially a guess, but experience shows the usual range of values is small. An estimate of 20-25 percent oil saturation is quite realistic; where the reservoir is unusually tight, a higher figure of about 30 percent may be more reasonable. Floodpot tests are useful for estimating the range of residual oil saturation after flooding, but the results of these tests sometimes are more optimistic than can be expected in the field. The residual oil saturation of flushed cores may be used as some criterion, but these values generally are on the optimistic side.

The pore volume of the area to be flooded then must be determined. Under ordinary circumstances the area of the reservoir which can be flooded is limited to that enclosed by the outermost wells in the flood program, which is somewhat less than the area which contributed to primary production.

The quantity of oil represented by the desaturation of the floodable pore volume from the present to the final residual oil saturation is that subject to movement by the flood. Not all of this is recoverable, because of limitations imposed by reservoir characteristics. An efficiency factor must be applied to take into consideration both the areal and the vertical coverage of the reservoir by the flood. The areal efficiency accounts for the fact that under normal circumstances not all of the area within the flood pattern can be swept effectively, because of unavoidable variations in well spacing, and mechanical difficulties involving flood control. Vertical efficiency accounts for the effects of permeability variation and the continuity of sand layers between wells in a flood pattern. Experience has shown that the usual range of areal efficiency is between 70 and 90 percent, and the vertical efficiency between 60 and 80 percent. The range of the product of the two, therefore, usually is in the order of 40 to 70 percent, with a median of about 55 percent.

The water-flood reserves then may be calculated from the equation:

$$\text{Reserves} = 7758\ \phi Ah \frac{(So - Sro)}{\beta} E$$

So = Oil saturation at start of flood, as decimal fraction
Sro = Assumed average residual oil saturation at depletion of flood, as decimal fraction
β = Formation volume factor at start of flood
E = Flood efficiency factor, decimal faction

Projection of Producing Rates. The accuracy of a projection of water-flood performance is limited by the amount of data available for making the calculations. Where complete core analyses are available from every well in a close-spaced area, the degree of accuracy of such a prediction can be very high. Where a lesser amount of basic data are available, a projection can be made which, although not precise, will be useful for a preliminary economic analysis. It should be emphasized that the procedures discussed in this article are for a 5-spot pattern flood, where the operator has reasonably good control of the injected water and no serious operating problems are involved. The calculations employ a number of experience factors which are based on the performance of a large number of successful floods.

The keystone of this calculation is the convenient approximation that the total volume of water required to deplete a pattern type water-flood is about 1.5 times the total pore volume of the reservoir to be flooded. This factor is subject to some modifications depending upon the permeability distribution and other factors which may limit the control of the operator. If it

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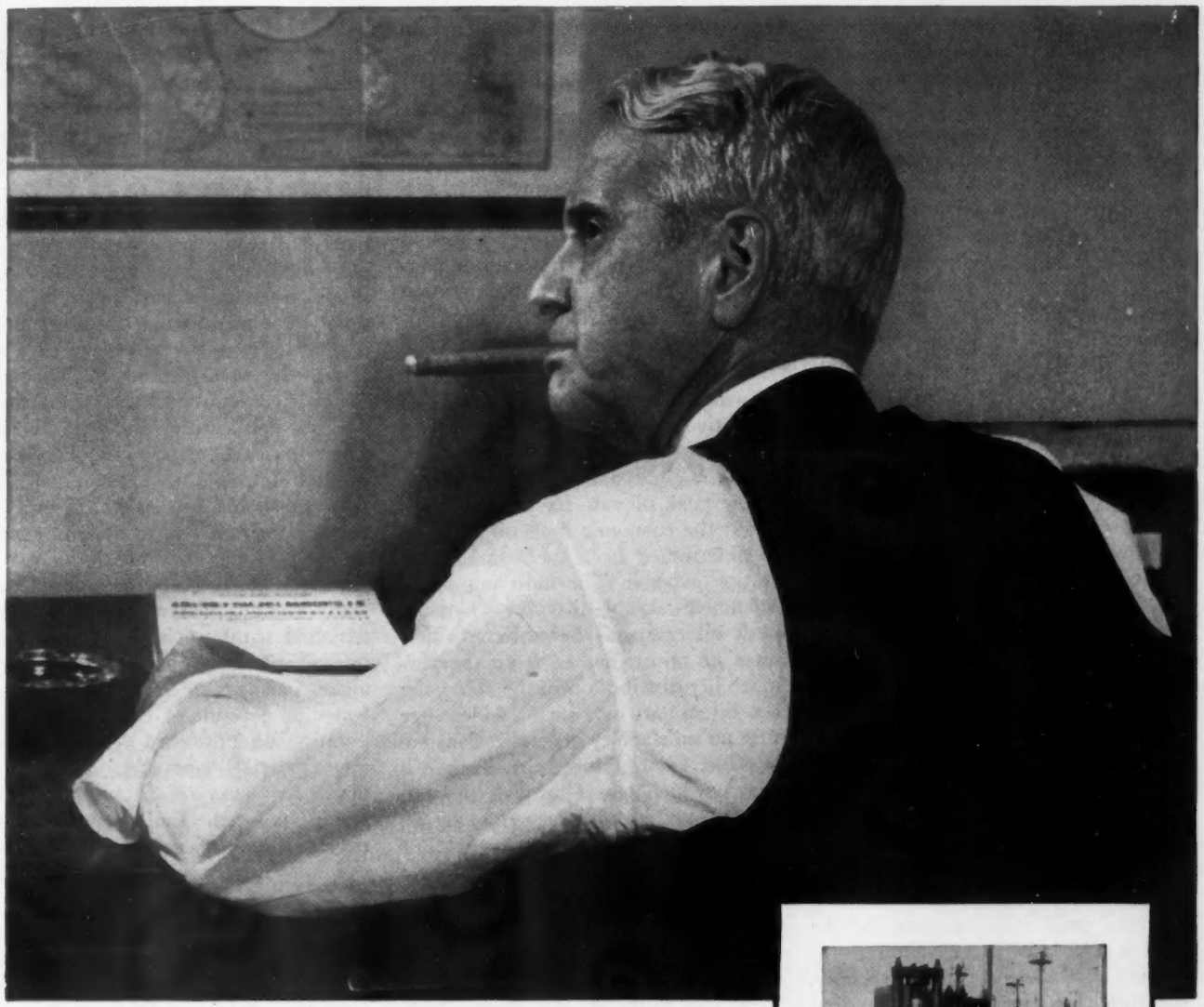

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is presumed that some water channeling may occur, it might be desirable to use a higher number such as 1.75 or 2.0 times the total pore volume. Ideal situations are known where the total amount of water required was somewhat less than 1 pore volume. One way to justify such an assumption is on the basis of cumulative water-oil ratio at depletion. For example, if 30 percent of the pore volume constitutes mobile oil, and an efficiency factor of 50 percent is assumed, the net oil recovery of 15 percent of the pore volume with a cumulative injection of 1.5 pore volumes represents a cumulative water-oil ratio at depletion of ten, which is in line with normal experience.

The second step is to determine, by well-testing, calculation, or by analogy with comparable reservoirs, the average settled injection rate per well which may be attained. It should be noted that short term injection tests usually show higher injection rates than can be sustained for a long period of time. Calculated injection rates using available permeability data are not infallible, but they indicate the general range of rates which may be attained.

The time required to complete the flood then can be calculated, knowing the total daily injection rate and the total amount of water required for depletion. Conversely, if one knows the total volume of water required and the approximate injection rate per well, the number of injection wells required can be determined for depletion within a specific period of time. In planning a water-flood, the operator always should make allowance for the possibility that individual wells or groups of wells may have lower injection rates than may have been anticipated.

The "fill-up time," or the time when the first response from the flood should be observed, then can be calculated. This is unusually equal to the number of months required to inject an amount of water equal to 2/3 of the void space of the reservoir. This may be calculated as follows:

$$\text{Fillup time} = \frac{213\ (7758\ AH\ \phi)}{(1 - Sw - So)}$$

In this calculation allowance should be made for the fact that some water will move into the edge areas beyond the last row of wells within the reservoir.

The total fluid production of a water-flood should stabilize at a rate equal to the total injection rate, assuming no loss of fluid from the reservoir. The peak oil rate seldom is over 85 percent of the total injection rate, and frequently is appreciably less, depending upon the permeability distribution and localized variations in reservoir conditions and injection rates. The 85 percent value is convenient to use as a first approximation of peak oil rate, when estimating future performance of the flood.

The construction of a decline curve showing future performance of a flood is relatively simple. The secondary reserves, the dates of first response and depletion, and a first approximation of the peak oil rate have been calculated; the economic limit oil rate can be determined from the assumed operating expense. The most important unknown factor is the time when the peak oil rate may be expected. This must be approximated from the permeability distribution of the reservoir; conditions vary over such a wide range that no satisfactory generalizations are possible. By trial and error, a curve is drawn which passes through the calculated points, and accounts for all of the secondary reserves. At this time the peak oil rate and the duration of the flush production should be reviewed critically in the light of such data as are available concerning permeability distribution.

If the bulk of the permeability capacity is represented by a relatively thin, high permeability section, a high peak oil rate of short duration can be expected to occur shortly after the first response is observed. If the reservoir has a more normal distribution of permeability capacity, the curve should show a more gradual rate of decline after the peak rate, and the peak rate may need to be estimated at a much lower figure than 85 percent of the injection rate in order to provide for the longer period of flush production. If the reservoir is predominantly all tight sand, the production rate will increase only moderately, with a very slow rate of decline after a low peak rate.

Economic Factors. An analysis then should be made of the factors which contribute to the capital investment and the operating costs of the flood. These include such items as the costs of developing and treating the water to be used for injection, the costs of drilling and recompleting wells, installing water distribution lines, revamping the gathering system, providing for well testing facilities, developing a supplementary source of power for continued operation of the lease and the possible need for larger pumping units.

The development of an adequate source of water is becoming increasingly difficult in many areas. A survey should be made of well logs and drill stem test information to determine if satisfactory water sands are present above the reservoir to be flooded. Alternative sources include lakes, streams, fresh water wells, produced water from other reservoirs and waste water from domestic or industrial use. Analyses should be made of the water selected for injection to determine the degree of water treatment which will be required for safe operation. The water treating system also should be designed with provisions to minimize or prevent the growth of bacteria or algae. Changes in the stability of the water as a result of changes of temperature and pressure also should be investigated. Plans also should be made for measures to mitigate corrosion, or for the replacement of vulnerable items of equipment periodically if corrosion is an extreme problem.

It is assumed that maximum use will be made of old wells for the flooding program, although a few new wells may be required to complete the development. A study should be made of the completion interval of each of the wells to be used in the flooding program, to determine if it is necessary to deepen certain wells, run blank liners or plugs in others to shut off gas producing zones or bottom water or to squeeze cement the casing if high pressure operation is planned. Wherever possible, wells used for injection service should be cleaned out and backwashed to remove cavings, paraffin or other materials which may have plugged the sand face. A study also should be made of the records of any wells which have been abandoned in the area to be flooded, to make certain that they are properly plugged. Provisions should be made for the installation of adequate pumping units to handle the total volume of fluid which will be produced. It is highly desirable to include facilities to test each producing well on a periodic schedule. If the property is being operated by gas-powered equipment prior to the

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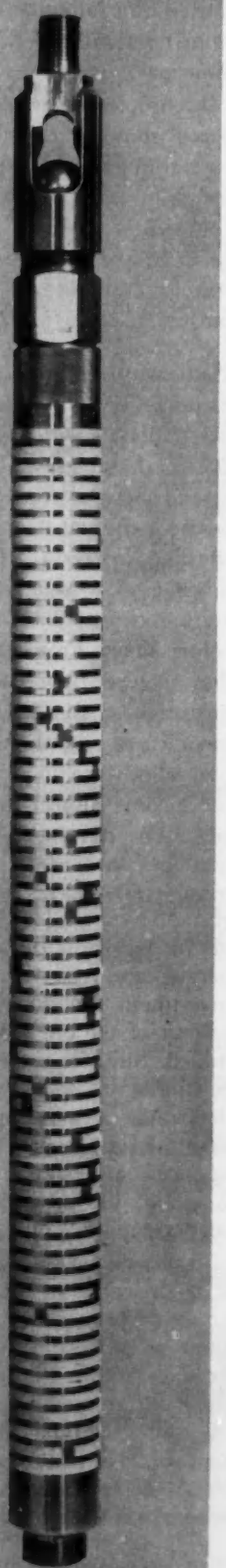

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flood, it may be necessary to convert to electric power unless a supplementary source of gas can be acquired. In most instances, shortly after a flood is started, the amount of available gas from reservoir will diminish to a volume inadequate for lease use.

A complete schedule should be prepared showing the total amount of capital investment required to develop the flood and the periods when investment is required. A similar analysis should be made to project the operating costs of the flood program through to depletion.

Evaluation. An evaluation then can be made of the economics of the proposed flood operation, in such detail as may be required. This evaluation should show by years the gross oil production, the net oil production to the working interest ownership, the net revenue to working interest, the operating expense, and the net income before taxes. From this are deducted the allowed depreciation on capital investments, the intangible development costs, and the applicable depletion allowance in order to calculate the income subject to tax during each year. The difference between the annual net income and the income tax payable is the amount of cash generated by the project. From an analysis of the cash flow during the operating period and the schedule of capital investment for the development, the payout of the operation can be determined. Suitable discount factors may be applied to each year's cash flow to determine a total net worth of the operation if desired. This will give the operator an estimate of the present worth of the property, based on the cost of capital.

It should be emphasized again that it is desirable to make an economic analysis for each of several assumptions of flood performance, as may be suggested by the preliminary analysis of the project. In this way a range of values can be determined which will bracket the possibilities of the flood, depending upon circumstances which may arise.

ACKNOWLEDGMENT

The writer has drawn freely upon the current literature on water flooding to such an extent that a complete listing of all the sources would be impractical. He wishes to express his appreciation in particular to the operators who have published the results of their flooding operations, both successes and failures, from which much can be learned.

How Fracturing Can Help Water-Flooding

It's no cure-all; each field and each well is a separate problem. There are indications, however, that nature can use a hand to penetrate that last few feet around the well bore.

By JESSE E. WYRICK

Production Engineer, The Pure Oil Company, Nowata, Okla.

ALTHOUGH HYDRAULIC fracturing methods have been available for about eight years, some producers engaged in secondary recovery operations, and especially in waterflooding, have been reluctant to use this technique. These operators are well aware of the dangers of pressure parting of the formation with resultant fluid channeling.

With increased knowledge and experience in fracturing methods, fracture treating in water flood operations is being more readily accepted and in many flooding projects both water injection and oil production wells have been fractured.

Why Fracture. In Nowata County Oklahoma, The Pure Oil Company has sand fractured several oil wells. The reasons for selecting the particular wells for treatment are varied. Some of the wells fractured were edge wells from which little production could be expected. Some had approached fill-up but had not yet begun to produce due to permeability barriers in the vicinity of the well bore. Some had been prolific producers but had gradually plugged themselves by the deposition of calcium sulfate and barium sulfate in the vicinity of the well bore. The one thing that all of these wells had in common was that they had approached fill-up and also that they were producing very little fluid.

Treatment. The size of the fracture treatments ranged from 500 gallons of fracturing fluid with 1000 pounds of sand to 5000 gallons of fracturing fluid with 10,000 pounds of sand.

Low viscosity oil was purchased for some treatments and lease crude used in some instances. Sand used was the standard range 20-40. Fluid loss additives were used. Temporary plugging agents were utilized in a few treatments in an attempt to plug off the more permeable zones and thereby fracture the tighter sand zones.

Three typical well treatments are presented as examples. The results obtained from fracturing were considered to be commercially successful.

Results

• **Well A** was completed in May, 1952, with 5½-inch casing set at 1010 feet with 15 sacks of cement. The Bartlesville sand was shot with 87 quarts of liquid nitroglycerine from 1020 feet to 1055 feet. The well began producing in June, 1952, with an initial production of 18 barrels of oil per day and no water. Although the rate of production was never high, it remained satisfactory until late in 1954 at which time total fluid production began declining at an alarming rate.

In December, 1954, a cup type hold down packer was set at 933 feet

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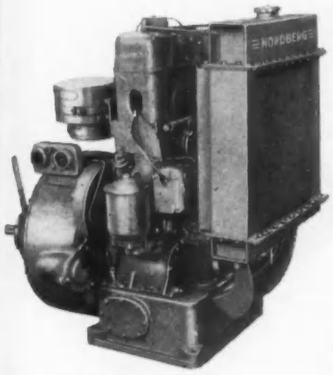

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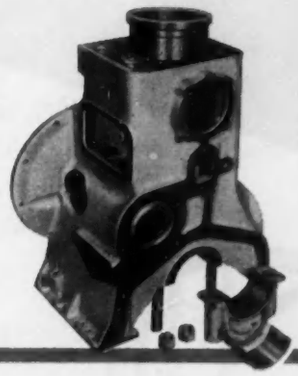

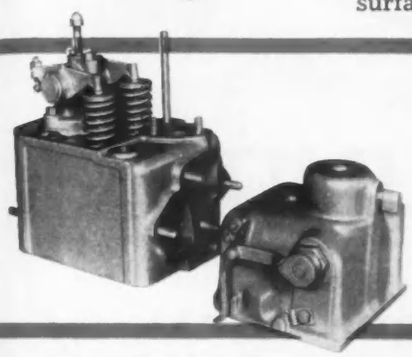

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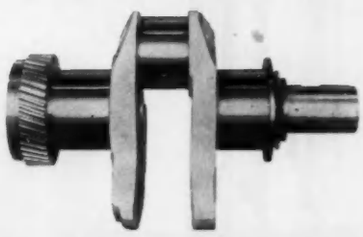

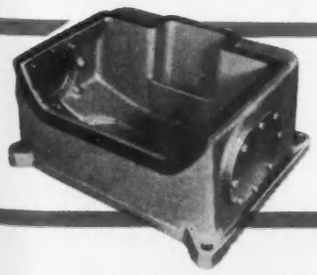

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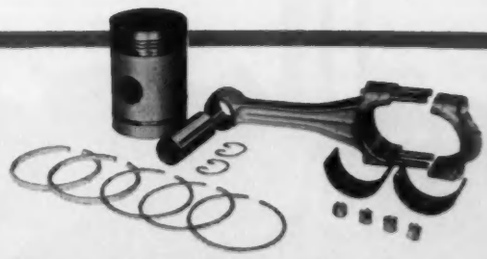

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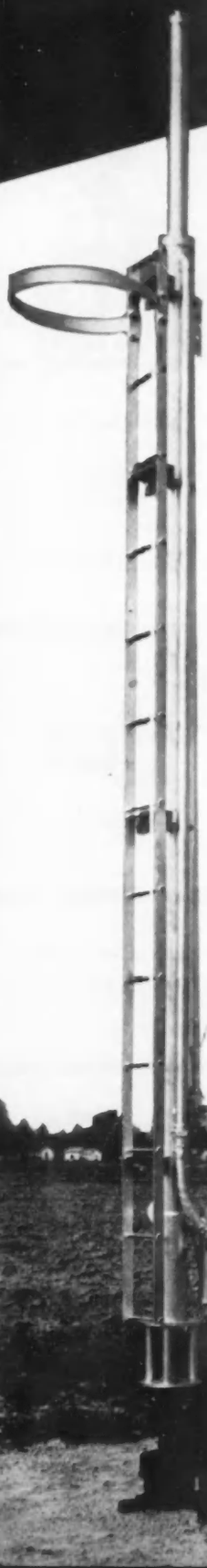

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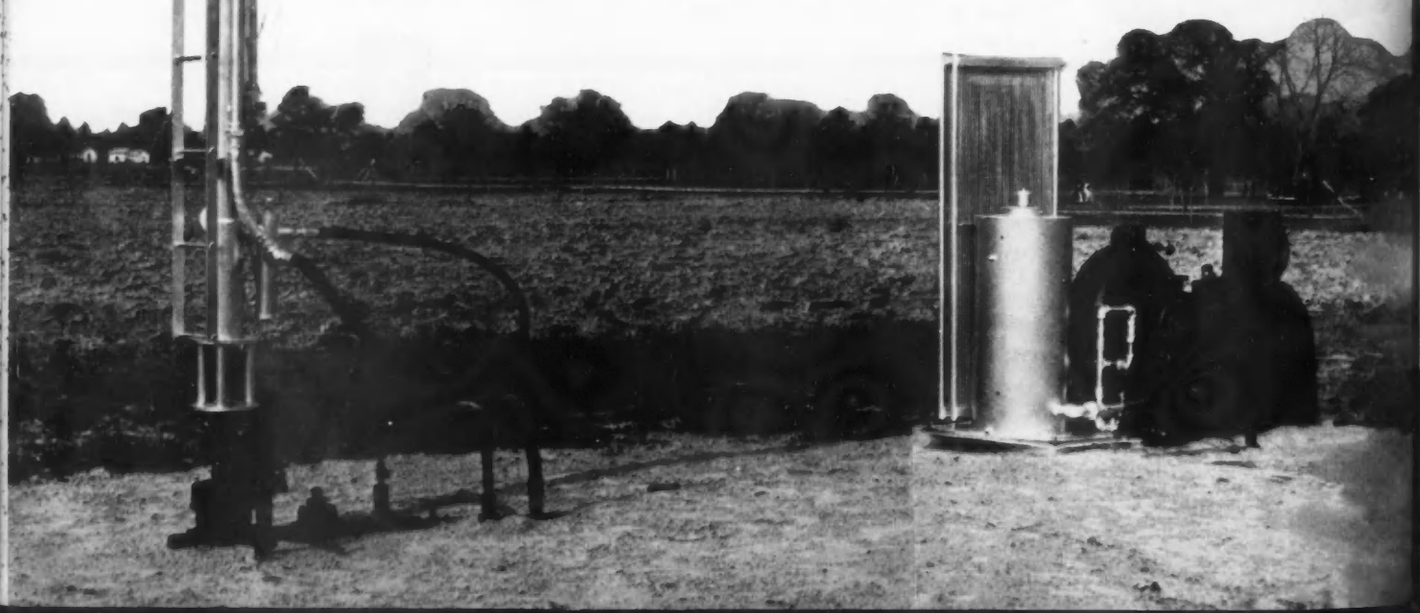

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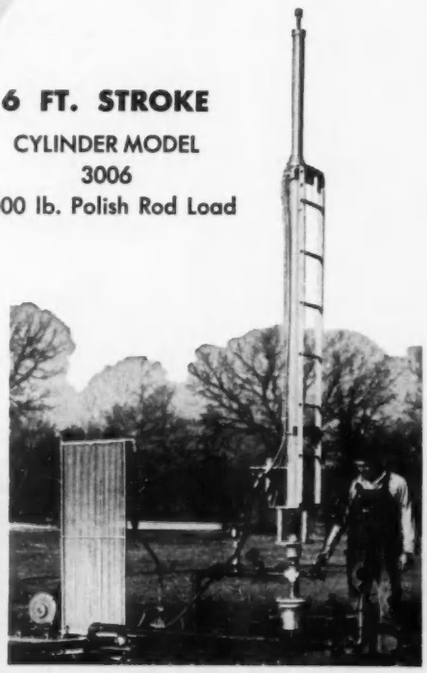

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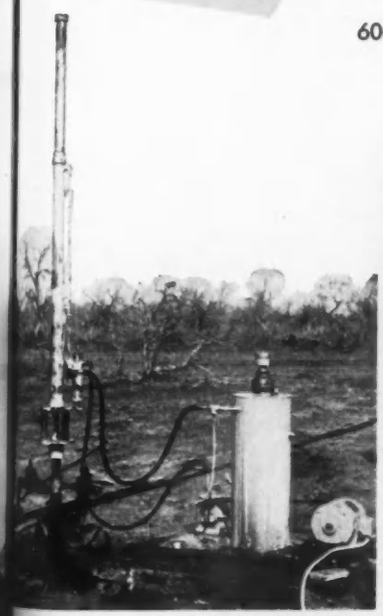

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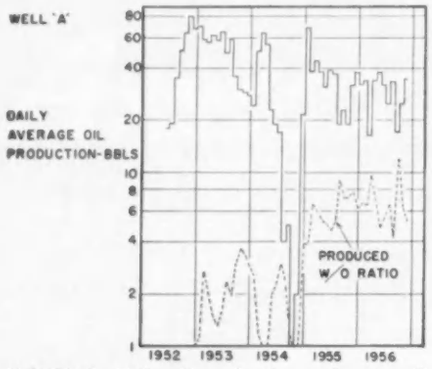


FIGURE 1—Daily oil production and water-oil ratio of a well in a flood project. Production jumped from 2 barrels of oil and 2 barrels of water a day before fracturing to 72 barrels of oil and 194 of water after treatment.

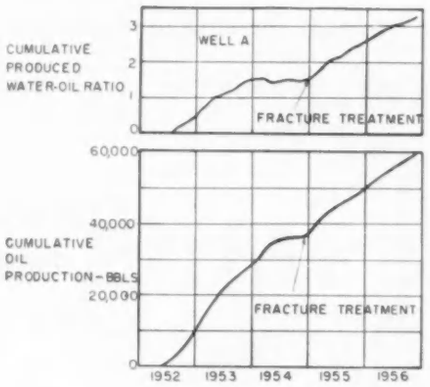


FIGURE 2—Cumulative oil production and water-oil ratio show the results of fracturing treatment. Injection in offset injection wells rose 90 barrels per day during month after treatment.

on 2-inch tubing, and the well was fractured with 3000 gallons of oil and 6000 pounds of sand. The production before reconditioning was two barrels of oil and two barrels of water per day. The production after reconditioning was 72 barrels of oil and 194 barrels of water per day.

Figure 1 shows the daily oil production and water-oil ratio. Almost every anomaly on this graph can be explained. However, it is beyond the scope of this article to delve into production problems other than those having a direct bearing on the fracture treatment of this well and only the general trend of production should be noted.

Through November, 1956, this well had produced approximately 23,369 barrels of oil since fracturing as compared to approximately 36,328 barrels of oil produced before fracturing.

Figure 2 shows the cumulative oil production and cumulative water-oil ratio.

Injection into offset water injection wells increased 90 barrels per day during the month following this treatment as compared to the month preceding this treatment.

• **Well B** was completed in June, 1949, with 5½-inch casing set at 1025 feet with 15 sacks of cement. The well began producing water flood oil early in 1951. In February, 1953, the Bartlesville sand was shot from 1035 feet to 1078 feet with 43 quarts of liquid nitroglycerine. By 1955, the fluid production from this well had declined until remedial work became necessary.

In October, 1955, a packer was set at 1000 feet on 2-inch tubing, and the well was fractured with 2000 gallons of lease oil and 4000 pounds of sand. The production before treatment was four barrels of oil and eight barrels of water per day. The production after treatment was 64 barrels of oil and 96 barrels of water per day.

Figure 3 illustrates the daily oil production and water-oil ratio. Some irregularities in this graph are caused by the well being shut in during part of May, 1952, and the well being shot with liquid nitroglycerine in February, 1953.

Through November, 1956, this well had produced 10,141 barrels of oil since treatment as compared to 35,783 barrels of oil produced prior to the fracture treatment.

Water injected into the well B injection pattern increased an average of 17 barrels per day per well following this fracture treatment.

• **Well C** was completed in December, 1952, with 5½-inch casing set at 1003 feet with 15 sacks of cement. The Bartlesville sand was shot with 50 quarts of liquid nitroglycerine from 1008 feet to 1028 feet. Although the well became active in January, 1953, an accumulative total of only 2851 barrels of oil and 583 barrels of water had been produced through October, 1954. On November 1, 1954, the well was fractured using 3000 gallons of oil and 6000 pounds of sand and through a packer set at 995 feet on 2-inch tubing. The daily production before treatment was one barrel of oil and three barrels of water. After treatment the production was 46 barrels of oil and 207 barrels of water per day.

Since the fracture treatment, 13,696 barrels of oil have been produced through November, 1956.

Figure 4 shows the daily production and water-oil ratio and Figure 5 is the cumulative production and water-oil ratio.

Water injected into the Well C injection pattern increased an average

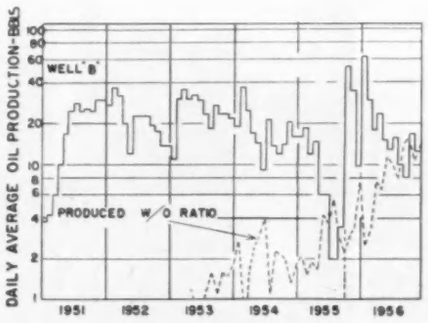


FIGURE 3—Daily oil production of Well B shows results of fracturing in October, 1955. This well produced about 10,000 barrels of oil after treatment, compared to 35,700 barrels in six years before.

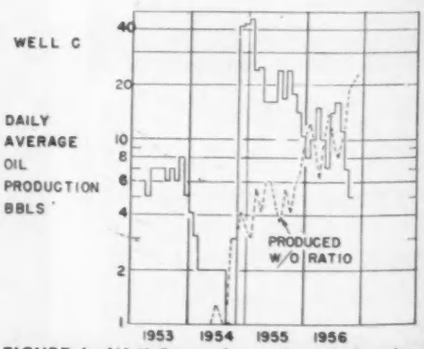
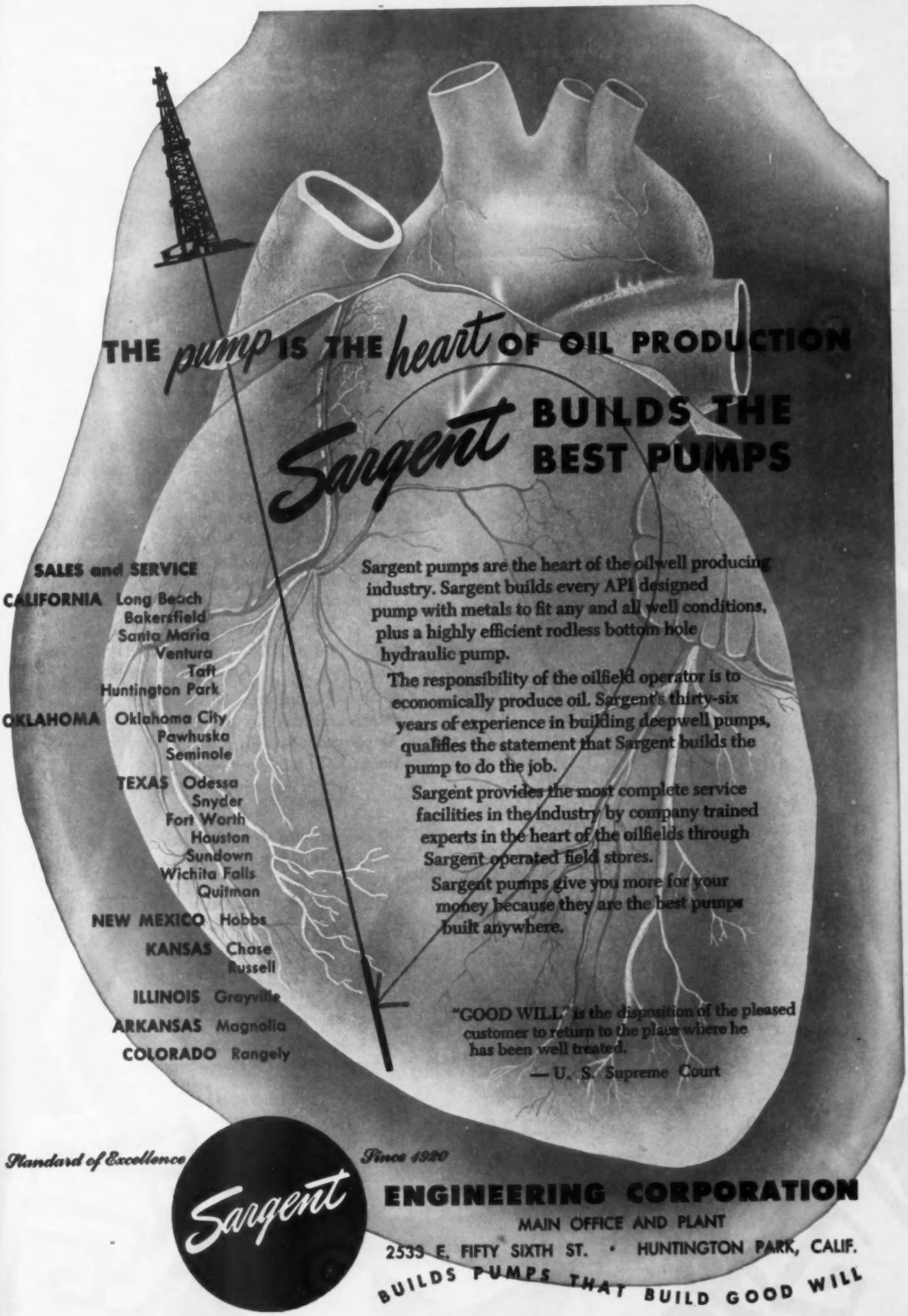


FIGURE 4—Well C was shot with nitroglycerine in 1952; daily production figures show an increase from 1 barrel of oil and 3 of water to 46 barrels of oil and 207 barrels of water after fracturing.



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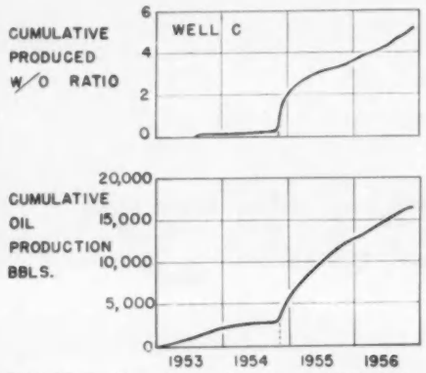

FIGURE 5—Cumulative figures for Well C indicate that the fracturing was helpful. Injection into the Well C injection pattern increased an average of 15 barrels per day per well following fracture treatment.

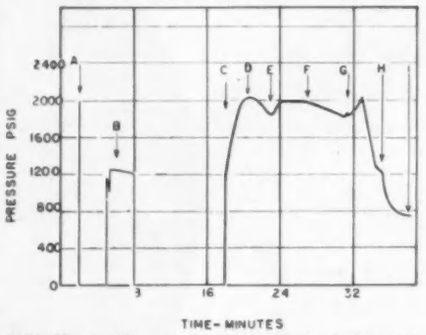

FIGURE 6—The steps in a typical fracture treatment of 3000 gallons of oil and 6000 pounds of sand can be followed on this graph.

of 15 barrels per day per well following this fracture treatment.

Figure 6 illustrates a typical fracture treatment of 3000 gallons of oil with 6000 pounds of sand. Surface pressure is the ordinate and time the abscissa. The letter designations on the graph represent the following:

A — Test connections
B — Broke down formation with 20 barrels of 36-degree crude oil at an average rate of 6⅓ barrels per minute.
C — Start sandfrac—¾ pounds per gallon.
D — Increased sand to 1½ pounds per gallon.
E — Increased sand to 2 pounds per gallon.
F — Increased sand slightly.
G — Sandfrac in at average rate of 6 barrels per minute—Start flush of 12 barrels 36-degree crude oil.
H — Flush complete—average rate 6½ barrels per minute.
I — Shut-in pressure of well.

What are the reservoir mechanics which should be considered in the fracturing operation?

Let us assume a homogenous reservoir with radial flow. Based on the D'Arcy equation for linear flow $Q = \frac{KAP}{uL}$, Muskat offers the following equation for computing radial flow to a well:

$$Q = \frac{2\,\Pi\,K\,T\,P}{u \ln \frac{R}{r}}$$

Q rate of flow
K coefficient of permeability of sand
T thickness of sand
P differential pressure between well bore and some chosen point in the reservoir
u viscosity of liquid
R distance from well bore
r radius of well bore
(See Figure 7).

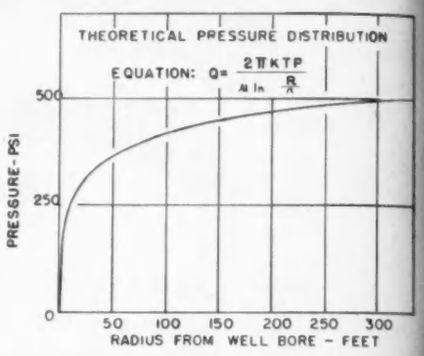

FIGURE 7—This theoretical pressure distribution within the well is based on homogeneous reservoir with radial flow. It incorporates some of the reservoir mechanics which should be considered in the fracturing operation.

Let us make the following assumptions for an illustrative well and reservoir:

(1) There is only one flowing phase.
(2) There is a constant rate of flow.
(3) The viscosity of the liquid remains the same throughout the reservoir.
(4) The sand has uniform thickness and permeability.
(5) The characteristics of the reservoir, reservoir fluids and rate of flow are such that the well bore has 0 pressure and a place within the reservoir located 330 feet from the well bore in a radial system that has 500 psi pressure. From the above set of conditions Figure 7 indicates the theoretical pressure distribution within the reservoir.

A large percentage of the pressure drop occurs within a few feet of the well bore. Although the above conditions will never be encountered in a reservoir, still much of the total reservoir energy is utilized to move fluids the last few feet into the well bore. This will be true whether fluids are being injected into the formation or being removed.

All methods that can be utilized to remove flow restrictions from the area of the well bore should be considered. Actual fracturing of the formation by the use of nitroglycerine or sand fracturing may be used in some cases. There is no one method of increasing the productivity index that will be successful in every instance. Every field and every formation and every well require individual consideration. —**The End**

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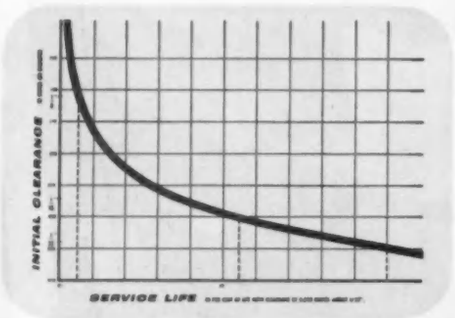

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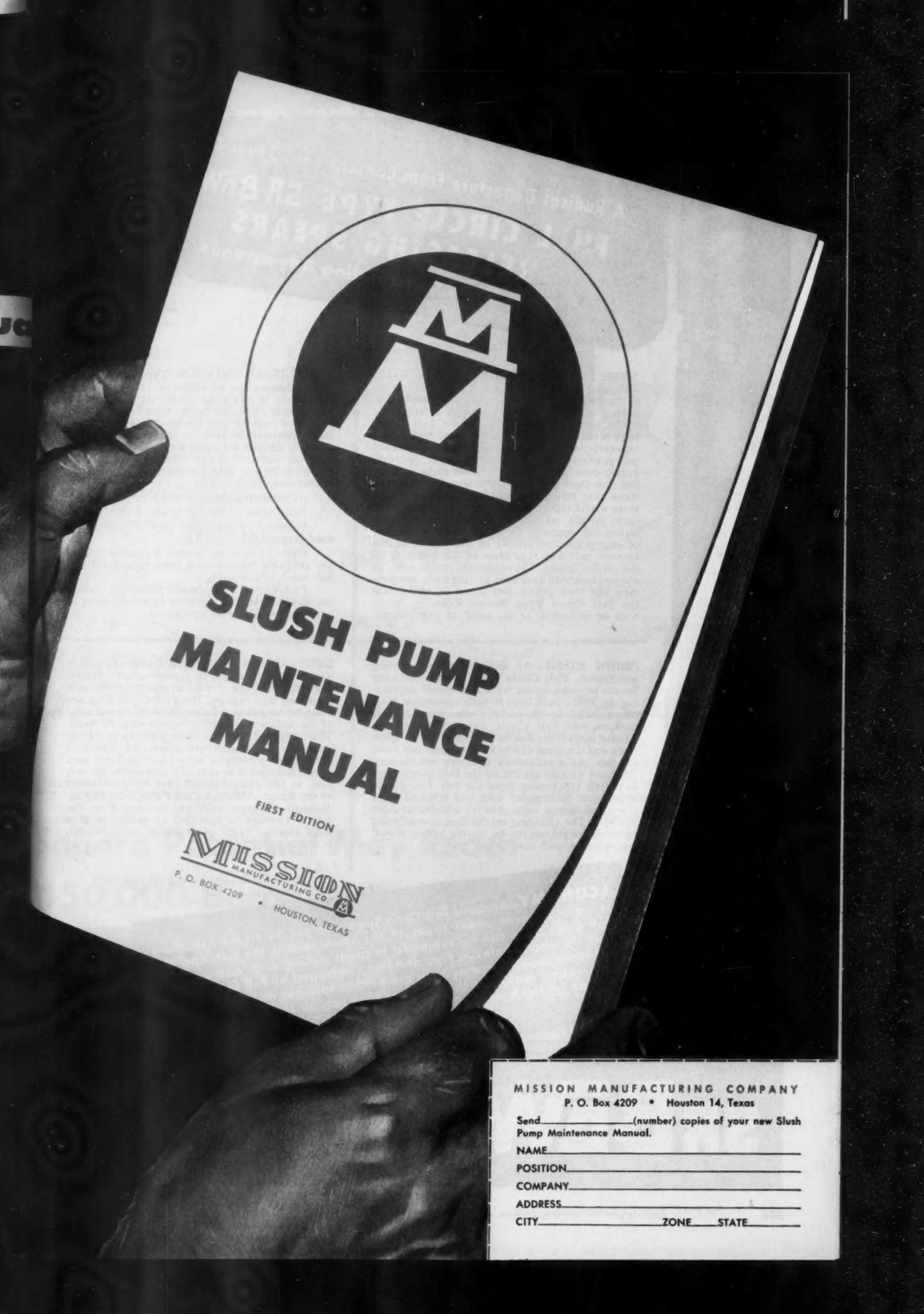

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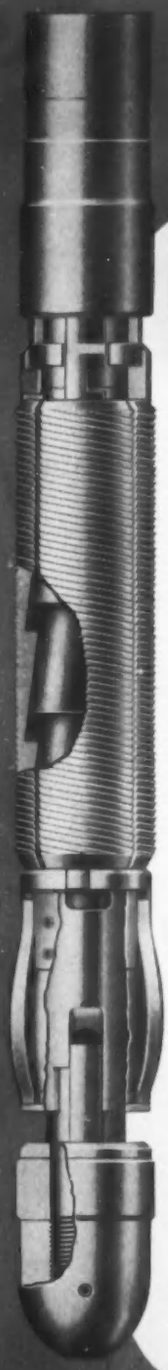

Full Circle Type Bowen Releasing Spear for casing

Safety Ring Pack-off

SECURE ENGAGEMENT—Full Circle Type Bowen Releasing Spears utilize novel Full Circle Slips that contact virtually the entire inner surface of a long section of the fish, and in addition, the entire inner circumference of the Full Circle Slips is backed by tapers on the spear body. Consequently, when a fish is engaged and upward pull is exerted, the expansion strain is spread so evenly over so much of the inner surface of the fish that there is no fish distortion. Comparisons show that this Spear has from 35% to 450% more useful slip engagement area than any other spear on the market today! Full Circle Spears insure the operator that there will be no loss of engagement regardless of the degree of the upward pull and regardless of the intensity of the jarring blows. On numerous actual jobs, in conjunction with hydraulic pulling tools and jars, pipe has been pulled and jarred in two below the Full Circle Type Bowen Releasing Spear with no distortion at the point of engagement.

VERSATILITY—All Full Circle Type Bowen Releasing Spears can be equipped to pack off the fish simply by removing the Safety Ring and by installing in its place a Safety Ring Pack-off. This one-piece pack-off attachment utilizes the circulation pressure to seal its rubber into a leak-proof fit against the inner walls of the fish. The radically different design of Full Circle Type Bowen Releasing Spears permits the use of other accessories which insure:

Alignment of the Spear with the fish.

Penetration of the fish to any desired depth.

Entrance of the Spear into a battered or sand-plugged fish.

Full Circle Type Bowen Releasing Spears are available for use with both right hand and left hand fishing strings.

Full Circle Type Bowen Releasing Spears are ideal to use with a Bowen Internal Cutter to perform cut and pull operations.

POSITIVE RELEASE—As their primary releasing mechanism, Full Circle Type Bowen Releasing Spears provide means for hanging and supporting the Full Circle Slips in their uppermost position relative to the spear body. When in this position, the Full Circle Slips cannot be expanded against the fish by the tapers on the spear body and the spear can be easily withdrawn from the fish. As a secondary releasing mechanism, left-hand wickers are cut on the Full Circle Slips to permit unscrewing from the fish. Full Circle Spears can be engaged with and released from a fish indefinitely without being withdrawn from the hole. The releasing mechanism is unaffected by excessive pulling strains, terrific jarring blows, and adverse well conditions.

SAFETY—All Full Circle Type Bowen Releasing Spears are engineered to provide greater tensile strengths than the tensile strengths of the pipe sizes that they engage. The Full Circle Slips are designed to collapse below the outside diameter of the Safety Ring or the Safety Ring Pack-off. This feature insures the Spear's ability to release from any fish that it has penetrated. The Full Circle Slips encompass so much of the inner area of the fish that it is virtually impossible for any junk to fall alongside and foul the mechanism of the Spear. Although each Full Circle Slip individually engages with and releases from the fish, a Unitizer is provided to make the slips work together in the event that a misshapen fish is encountered.

Available in tubing and drill pipe sizes.

ECONOMY—Because Full Circle Spears do not distort the fish, there is no movement under strain of the spear within the fish and the Full Circle Slips can be subjected to great pulling and jarring strains with no wear whatever. Pipe and liners salvaged by Full Circle Spears are more usable because they are neither split nor distorted. Another time-saving feature is the fact that slips can be changed without removing the Nut from the Body.

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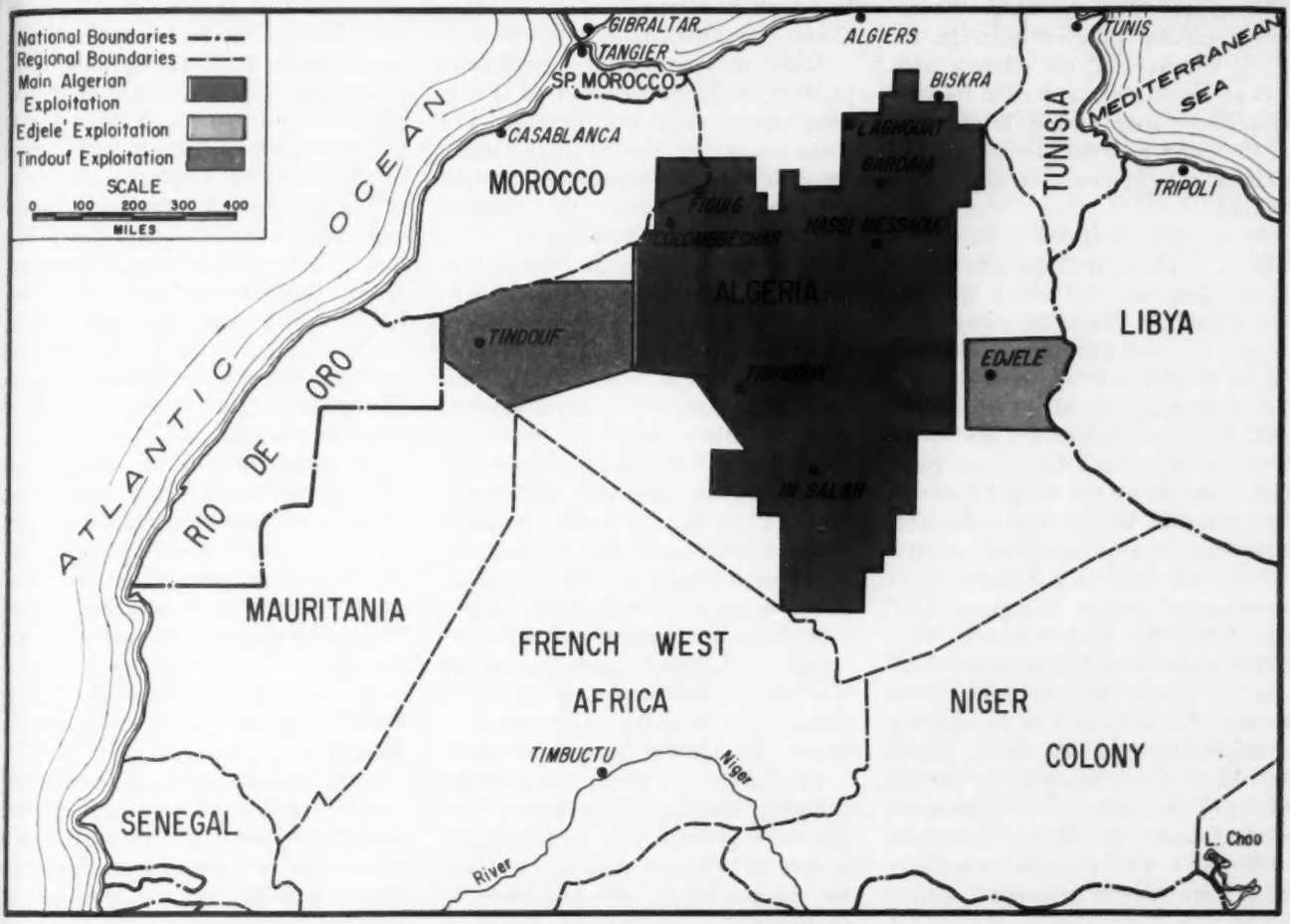


A pivotal position with $750 million for development by 1960.

If estimates prove correct . . .

Sahara Potential May Reach 450,000-Barrel Daily Level

France optimistic over African desert's crude reserves despite nation's need for money, equipment and technicians for fast development.

BENEATH THE SURFACE of the Sahara desert in North Africa enough oil, it is said, exists to supply all of Western Europe's requirements. But whether that is borne out by future development, France is optimistic over the belief that sufficient oil does exist in the Sahara to remove the costly and uncertain practice of importing 98 percent of its domestic oil needs from other sources.

Official French quarters have expressed the general opinion that a great power must control its oil supply, rather than depend upon the sometimes capricious whims of others. The Suez controversy gave rise to the most current re-statement of the view.

France controls 1,960,800 square miles of sedimentary formation in Africa as compared with the more than 1.5 million square miles existing in the U. S. So it has been felt that the discovery of sufficient oil to meet domestic requirements has depended primarily on the furnishing of capital for exploration and development work. For confirmation of this viewpoint, France looks only to Metropolitan France, where, with sufficient capital made available, the Parentis oil field was discovered in 1954 and Lacq in 1955.

Toward that end, the French government plans to spend $750 million by 1960 in developing its desert discoveries and in building pipe lines to transport the crude. Geologists esti-

mate that France has discovered in the Sahara oil deposits which may ultimately yield more than a billion barrels of crude.

Geographically, the Sahara occupies a pivotal position between the U. S., Europe and the Middle East. Just as North Africa showed its strategic importance during World War II, the Sahara could play an equally decisive role in event of any future conflict.

If, as current investigations indicate, it contains an abundant supply of oil, iron ore and other strategic raw materials, such as manganese, copper, tin, and tungsten, it could be one of the decisive factors in the continued strength of the Free World. Industrial installations set up on the desert fastness, far from enemy bases and protected by the Atlas Mountain range, would be far less vulnerable than those of any European country.

Too, the fact that Sahara oil is considerably nearer European markets than either Middle East or Venezuela crude could offer those markets a price advantage. Hassi Messaoud crude could be transported to Algiers by pipe line, thence across the Mediterranean Sea to French refineries at Marseilles by tankers—a total distance of slightly less than 1000 miles. Or, shipment could be made from Algiers to London, a total distance of 2200 miles.

The distance from the Persian Gulf to London, via the Suez Canal, is 6220 miles. The distance around the Cape of Good Hope jumps to 10,955 miles. The tanker route from the Persian Gulf to Rotterdam, via the Suez Canal, spans 6600 miles.

While mirages are the best known product of the Sahara, not all that is seen there today is a mirage. For some years, the French government, through nationally-sponsored companies, has been exploring the possibilities of oil and mineral deposits.

Reports of large oil deposits in Southern Algeria have been described in Europe as no exaggeration. One estimate speaks of reserves of about 7 billion barrels at Hassi Messaoud, less than 400 miles northwest of the Edjele discovery, near the Libyan border. If this figure is proved correct, the late discovery will greatly enhance Africa's oil reserve position (WORLD OIL, April, 1957, Page 235). In addition, the Edjele structure is believed to be at least 45 miles long.

If these preliminary estimates are confirmed, Sahara's crude production is expected by some sources to be capable of reaching a potential of more than 450,000 barrels per day.

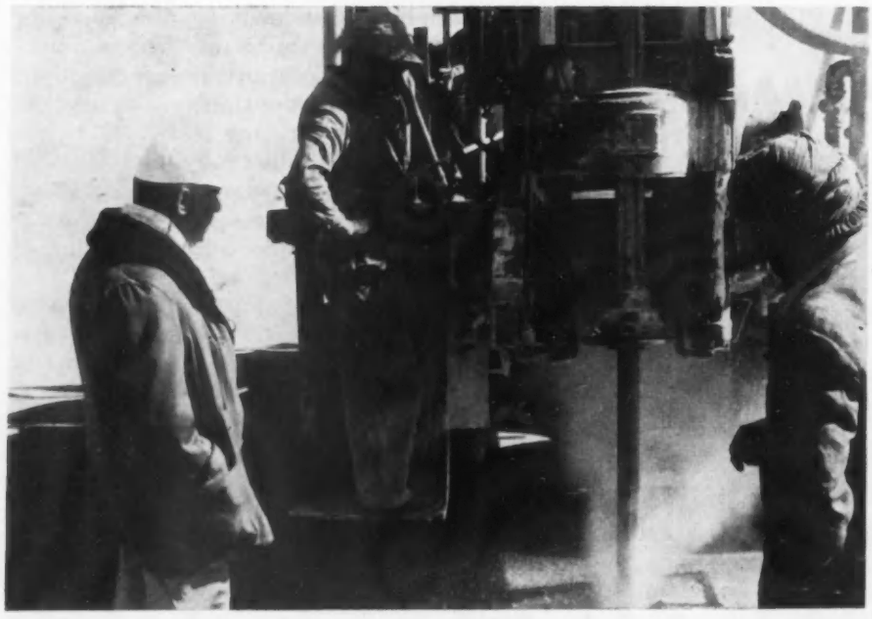
The fact that French plans for developing Sahara's oil resources have not received wide publicity probably is due to political caution. Without the good-will of the Algerians, in particular, as well as the Tunisians and Moroccans, the project could become another shimmering desert mirage.

Another—and perhaps greater—need for precaution against excessive publicity is a matter linked closely with present-day North African politics. Certain Paris circles have whispered that one of the main objectives of Nasser's support and financing of the self-styled Algerian nationalists is to get control of the Sahara oil potential as quickly as the revolt has weakened French authority sufficiently for him to move in. Nasser, oil poor as clearly shown by the precarious position of Egypt after the Suez conflict in November, could be expected to be in a greatly improved position should he be able to gain control of Sahara's potential.

Geographically, it is difficult to place the Sahara's exact boundaries. Its political administration is divided between Algeria, which is responsible for the largest part, Morocco, Tunisia, French West Africa, and French Equatorial Africa. The desert extends beyond the territories under French administration, i.e., Spanish Sahara, Libyan Sahara and an Egyptian Sahara.

Natural boundaries may be defined roughly as the Atlantic on the west, the Nile river on the east, Atlas mountains on the north, and the Niger and Senegal rivers on the south. Thus defined, Sahara has an area of almost 2.5 million square

Oil Is Sought . . .



While large crude reserves have been discovered in the Sahara, the search for even more oil deposits is continuing. This shot hole drilling crew is operating at Norafor, part of the 750,000 square miles of area where oil is being sought.

And

This is the site of Africa's Sahara desert's first big oil well at Edjele, deep in a trough in the eastern erg near the Libyan border. It is esti-

miles and a population of less than 2 million persons. Ninety percent of the Sahara is uninhabited. The cultivated area amounts to less than 500,000 acres; the remainder is grazing land or wasteland.

In the Sahara are vast plains, or *regs*, swept by the desert wind; regions of sand dunes, or *ergs*, which often look like a succession of waves but which sometimes reach a height of almost 1000 feet; cliffs which rise to 2500 feet and sometimes extend for hundreds of miles with but a few passes; enclosed basins, and mountains reaching to more than 11,000 feet.

The Sahara has no river or stream with a permanent flow from its source to its mouth. The only watercourses are *wadies*, which generally have no tributaries and which disappear before reaching the sea. Most of the time, the wadies are dry.

The Sahara's subterranean strata, which include almost 200,000 square miles of pre-Cambrian formations in Southern Algeria, are believed to contain lead, zinc, copper, tin, wolfram, and uranium. Likewise, the primary formations, about 125,000 square miles in area, are expected to hold iron and certain non-ferrous ores.

Then there are the important areas where oil is being sought. These cover about 750,000 square miles. The sedimentary nature of the geological layers making up the subsurface formations of the Sahara indicate the presence of oil.

Search for this oil is controlled by the Bureau d'Organisation des Ensembles Industriels Africaine, which was formed in 1952 under the chairmanship of Louis Armand, president of the French National Railroads.

BIA coordinates the action of the government-operated North African exploration organizations, which include:

1. Bureau de Recherches Minieres de l'Algerie.

2. Bureau de Recherches et de Participations Minieres du Maroc.

3. Bureau de Recherches du Petrole.

Regions of the Sahara not belonging to North Africa are under jurisdiction of the Bureau Minier de la France d'Outre-Mer.

Up to 1954, only the north part of the Sahara had been systematically explored and prospected. In the south, except for Mauretania, prospecting and subsurface exploration began in earnest in 1953-1954.

The search for oil encouraged by BRP is being conducted on the basis of permits granted to these five companies:

1. Societe Nationale de Recherche et d'Exploitation des Petroles en Algerie, which is owned jointly by BRP and the Algerian government.

At the end of 1952 SN REPAL obtained six permits covering 45,000 square miles and extending roughly from Biskra to El Golea between Diguig and the South Tunisian border. In 1953 the company got a permit for 16,675 squares miles in the Colomb-Bechar region and one for more than 3000 square miles in the Oued Saret.

2. Compagnie Francaise des Petroles Algerie, a subsidiary of Compagnie Francaise des Petroles, which was organized in 1953. CFPA has permits covering about 48,250 square miles which overlap those of SN REPAL. However, the two companies have concluded a cooperative exploration agreement.

3. Compagnie de Petroles d'Algerie, organized in 1953, is owned 65 percent by the Royal Dutch Shell Group, 30 percent by Regie Autonome des Petroles and 5 percent by BRP. The area held by this company covers 61,750 square miles south of the areas assigned to SN REPAL and CFPA.

4. Compagnie de Recherches et d'Exploitation de Petrole au Sahara, which was organized in 1953.

CREPS is owned 55 percent by RAP, 35 percent by Royal Dutch Shell, 5 percent by BRP, and 5 percent by SN REPAL. CREPS holds permits for 56,000 square miles south of the area held by CPA and extends from Adrar in Mauretania to the Libyan border.

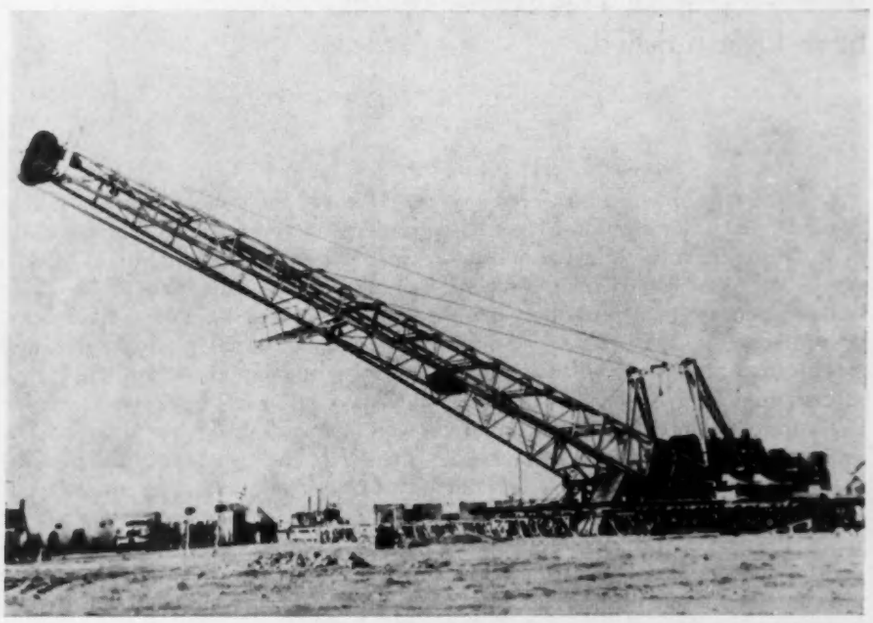
5. Societe des Petroles d'Aumale,

Continued on Page 268

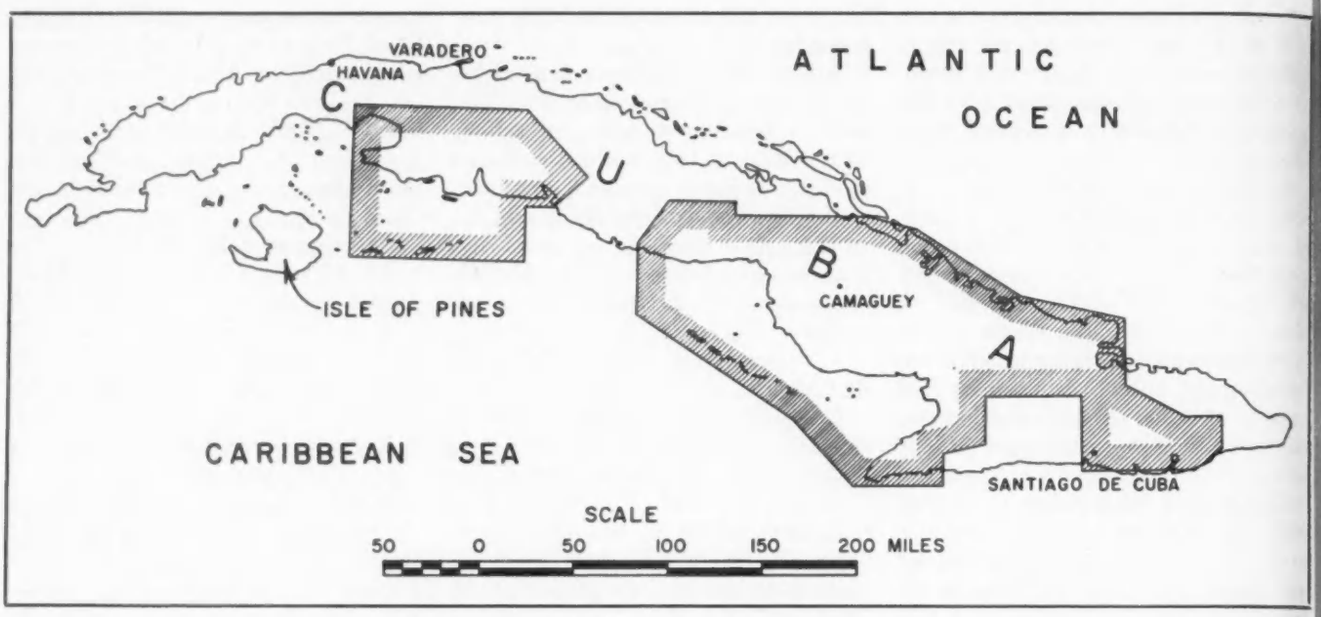
Found . . .

mated in France that about 28 million barrels of oil could be produced from this area in 1959.

Then Developed



Development operations are progressing in the Sahara as fast as funds, equipment and technicians permit. Here, at a new location at Berga, one of the new oil fields found in the desert, a crew is lifting the drilling mast on a light rig.



Cuban areas covered by Cuban Stanolind magnetometer survey.

35,800-Square-Mile Aerial Survey in Cuba Completed

Cuban Stanolind Oil Company exploration program on the island expected to progress rapidly as basic map work and reconnaissance magnetic operations have been finished.

FLYING HAS BEEN completed by Aero Service Corporation, Philadelphia, Penn., for a two-stage aerial survey of large blocks of Cuban territory under a permit granted by the Cuban government.

The total area involved was 35,823 square miles, of which 23,631 square miles were onshore and 12,192 square miles were off the island's southern coast. Since the total area of the Cuban mainland is 41,634 square miles, the survey thus covered 52 percent of the mainland. Had the entire area covered been onshore, it would have taken in 86 percent of the land area of Cuba, excluding neighboring smaller islands.

Most of the area surveyed is held under concession rights acquired late in 1955 by Cuban Stanolind Oil Company (WORLD OIL, November, 1955, page 252), which engaged Aero Service to make aerial photographic and airborne magnetometer surveys.

Basically, two blocks of acreage were involved in the aerial work. The smaller of the two takes in the southeast corner of Havana province, much of Matanzas, the southeast part of Las Villas, and extends to a maximum of 70 miles off the south shore to within 18 miles east of the Isle of Pines. The eastern and larger block includes parts or most of the provinces of Las Villas, Camaguey and Oriente and some near-coastal south offshore areas. Though the two blocks are not contiguous, together they take in most of the area in which Cuban Stanolind has interests.

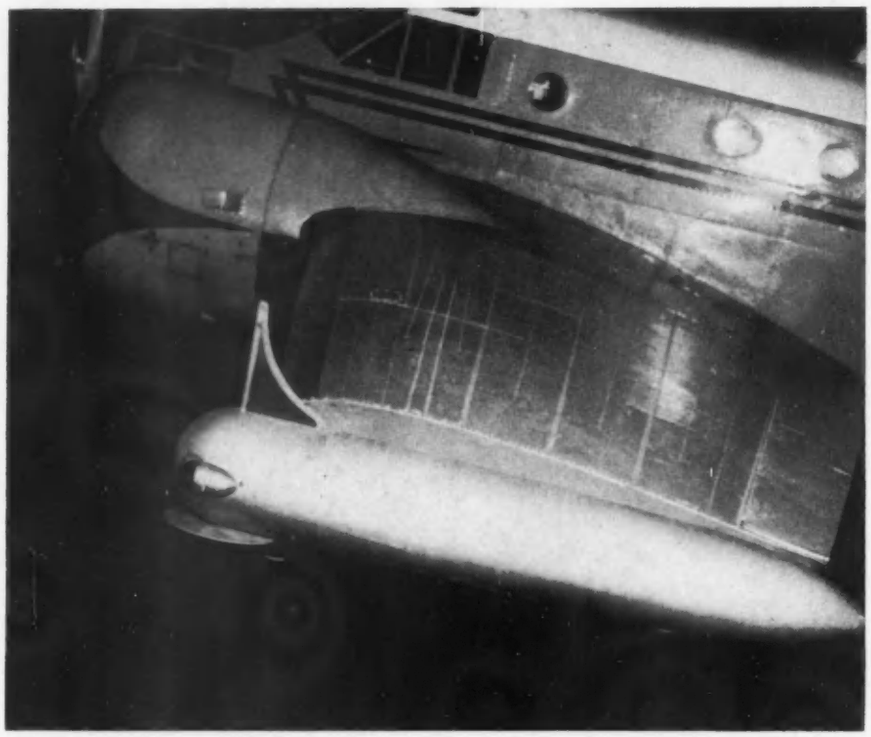
The first phase of the operation began in late December, 1955, and was completed March 15, 1956. The entire area involved was photographed from two specially modified P-38 aircraft. The airborne magnetometer survey began March 15 and was completed June 1. A twin-engined plane was used in the magnetic survey. The final phase of the operation, the compilation and planimetric work was expected to be completed in the late fall of 1956.

All phases of this work encountered interesting problems, some of which were overcome in unique ways. Cuban weather is not well suited to aerial photography, since the skies are cloudless only about one-tenth of the time, at best. It is a characteristic weather trait of tropical and semi-tropical islands to develop cumulus clouds by mid-morning even on relatively clear days. This effect was often a help to ship navigation in olden times as clouds will often mark the position of an island to a sea captain before land is visible, but it is a hindrance to modern aerial photography. To move the work along as rapidly as possible, use was made of relatively short periods of good weather, sometimes over small areas, and of the speedy P-38 of World War II fame to cover the territory as fast as possible.

To assure the best possible coordi-

Aerial Photography and Controlled Mosaic 1956, Aero Service Corp. Photogrammetric Engineers, Philadelphia, Penn.

This is one section of the photo-mosaic made for Cuban Stanolind Oil Company by Aero Service Corporation. Sancti Spiritus is in the upper left hand corner.



A magnetometer survey, begun upon completion of the photographic work, included an aerial radioactivity survey as a scintillation counter was operated at the same time. The detector used was a conventional Gulf high-sensitivity magnetometer which was rigged in a unique way—at the end of the left wing. It previously has been common practice to suspend the instrument as a trailing "bird" from the plane.

nation between the two-man crew, pilot and photographer-navigator, P-38's are equipped with a plastic bubble or "greenhouse" built into the nose of the ship. The photographer-navigator coordinates a drift sight with the camera angle. This is necessary because, in order to fly in a straight line, the wings of the plane (and, therefore, the plane itself), may not be exactly perpendicular to the flight line if the plane is bucking a wind. Unless some adjustment of the orientation of the camera is made, the resulting photographs will be oriented obliquely to the line of flight, rather than normal to it. This could, in turn, cause vacancies to occur in photographic coverage.

A precision mapping camera was used at an altitude of 32,000 feet. Each photo covered about 80 square miles, with a 60 percent forward overlap between pictures. The P-38's operated at about 300 miles per hour. Pictures were taken at intervals of about 45 seconds. A total of about 3000 photos were taken in 28 flights. The total number of flight hours was 160. The average month has about four days of clear weather, and the average number of clear weather flying hours per day was four. About 150 photos were taken per day. About 3000 square miles could be covered in a day's work. Mosaics were assembled from the nine-by-nine inch photos on a scale of 1:48,000, or one inch to 4000 feet.

Planimetric maps were finished in three sections for final presentation to Cuban Stanolind. They will be very useful to show ground and hydrographic features to develop base maps. The photographs, due to overlap, may be used for topographic mapping by use of multiplex equipment if desired.

Mapping of the surface geology of some of Cuba can be assisted considerably from careful examination and interpretation of the aerial photos. In the Sancti Spiritus area, in central Cuba, igneous, sedimentary, and metamorphic (often serpentine) outcrops can be determined from visual characteristics, and surface faulting can sometimes be determined from the air. In the Sierra de Cubitas region, about 25 miles north of Camaguey, northward dipping metamorphosed Cretaceous sediments stand out as resistant areas to the north, with cuestas marking the south rim of these beds. Clastic material to the south is interpreted as being mainly derived from a serpentinized igneous mass still farther south because of the lack of vegetation in the valley, a characteristic of serpentine surface areas. The Cretaceous surface area is rather heavily vegetated, or farmed.

Three bases were used for the photo work—Havana, Camaguey and Santiago de Cuba. Bases for the magnetic work were located at Veradero, Camaguey and Santiago de Cuba.

The magnetometer survey, begun immediately upon completion of the photographic work, included an aerial radioactivity survey, too, as a scintillation counter was carried and operated at the same time. The crew of the AT-11 aircraft consisted of three members, pilot, navigator, and magnetometer operator. The detector instrument used was a conventional Gulf high-sensitivity magnetometer, weighing between 20 and 30 pounds. For this operation, however, the instrument was rigged in a unique way—at the end of the left wing. It previously has been common practice to suspend the instrument as a trailing "bird" from a metal plane, or, in an unusual case, use was made of a plywood bomber with the instrument built into the fusilage as far away from any metal as possible (WORLD OIL, June, 1956, page 268, Australian Aerial Survey Reports Near Completion). The installation used in the Cuban Stanolind survey had the advantage that it was 16 feet away from the nearest engine. Also since it was built onto the wingtip, the instrument was more securely placed, rendering it more effective in bumpy flying weather than the conventional trailing "bird." But this involved complicating factors, too. The aluminum wings of the aircraft generate "eddy currents" if they move erratically in the earth's magnetic field.

Compensating adjusting features, both electrical and mechanical, had to be built into the magnetometer assembly, so that each action encountered in flight was compensated by an equal and opposite reaction, minimizing distortions that would otherwise impair the accuracy of the survey.

The AT-11 has two 450-horsepower engines. The altitude maintained was about 1000 feet above the terrain, almost all of which was below 3000

feet above sea level. Much of the land area covered is low, coastal plain country. The instrument worked well in its unique wingtip installation despite the heavy air turbulence often encountered which was very fatiguing to the crew. North-south lines were flown, with two-mile spacing between flight lines being observed. A recording altimeter noted altitude throughout each flight, and a continuous strip camera recorded the flight path on 35-millimeter film.

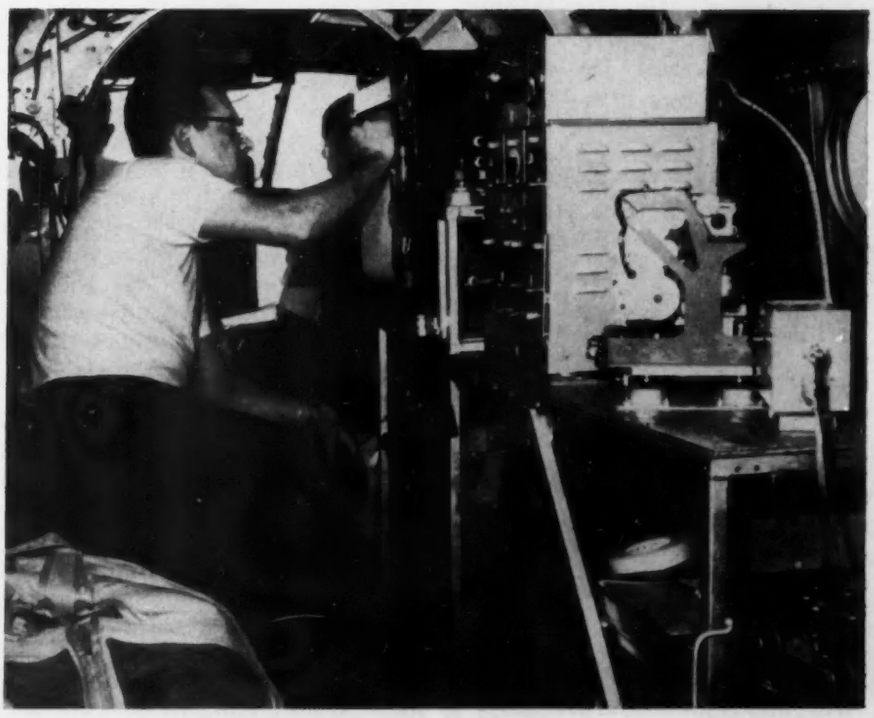
Isomagnetic maps with five gamma contour interval and a horizontal scale of one to 50,000 were being compiled from magnetic data.

During the magnetic survey, cognizance was taken of the magnetic weather through use of a ground monitoring station, where the same type of magnetometer used in the plane was read constantly to observe magnetic storms. Such storms occur when there is vigorous sun spot activity, and can confuse interpretation of magnetic data at least as thoroughly as they can cause garbled telegrams and cablegrams, their best known effect. Sun spot activity, of course, is erratic and unpredictable, and magnetic storms can occur during perfect weather conditions. Such magnetic storms have possibly been responsible for conflicting magnetic data and interpretation from the same areas in the past. Magnetic work was postponed during such storms in the Cuban operation.

Cuban Stanolind's exploration was expected to progress rapidly, now that the basic map work and reconnaissance magnetic exploration has been done. Dr. Robert E. Wilson, chairman of Standard Oil Company (Indiana) commented that Cuban Stanolind "had found some structures" but he hastened to add that exploration was still in the reconnaissance stage.

The geology of Cuba should afford interesting magnetic contrasts, since heavy ferromagnesian igneous and metamorphic rocks are present in many places with lighter sedimentary beds nearby. Now that at least one salt dome has been discovered in Cuba, along the north shore of the island in Camaguey Province, still greater contrasts in the magnetic values as indicated by such surveys of Cuba may be expected. —**The End**

Navigator-photographer adjusts drift sight in specially-made plastic nose of the P-38 used in the operation. This sight allows the operator to know how much deflection of the airship is being forced by winds and to adjust the sighting of the camera so it will be oriented parallel to the line of flight. Otherwise, the aerial photos might be oriented obliquely to the flight line, disrupting continuity of the mosaic or even causing vacancies in the coverage.



Magnetometer operator checks record tape during a survey flight over the Stanolind area.

Sahara Potential

Continued from Page 263

which holds a concession adjoining the CPA tract to the northwest of Biskra.

Currently, seven seismic and six gravimetric crews are operating in the Sahara, in addition to six drilling crews and several magnetometer teams. Recently, the cost of these exploratory operations for a one-year period amounted to more than $15 million, of which $1,628,000 was spent on geological surveys, more than $6 million on geophysical studies, and $7.5 million on drilling.

Even though an extensive oil reserve may exist in the Sahara, the problem of financing development of the oil fields is a big one for France. The nation is not wealthy, and the colonial campaigns of the post-World War II era have strained its resources seriously. Likely, that is the principal reason why progress on development work has been moving at what appears to be a slow pace.

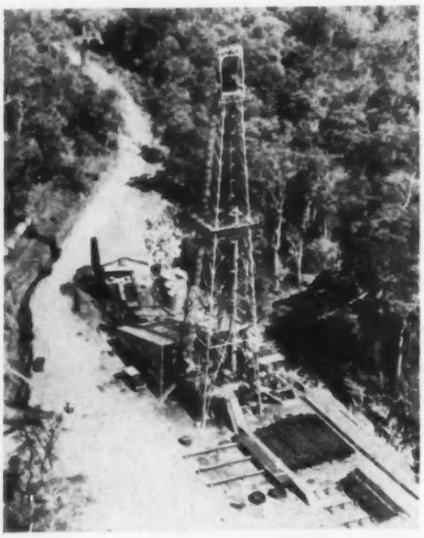
But the Suez controversy provided France with the added impetus necessary to speeding up operations. The government will provide what it can and already has received substantial financial aid from outside sources. But the need for even greater financing exists as the stage for actual development approaches. In addition to setting up installations and equipment and building pipe lines, housing must be constructed and water, a scarce commodity, provided.

It appears that one likely source for money will be Western Germany. This is because the Sahara, as a French possession—and Algeria is considered a part of Metropolitan France for administrative purposes—will form part of the proposed European Common Market, and Germany would be able to reap a substantial reward in the form of cheaper oil.

Investment from other countries, including the U. S., however, will be equally encouraged because development of the Sahara plainly is going to be a tremendous task. But such development will help strengthen international solidarity by the contribution it will make to the oil supplies of the Western World.

ACKNOWLEDGMENT

WORLD OIL acknowledges with appreciation data furnished by P. Bayle and C. F. Livingstone.



Yacimientos Petroliferos Fiscales' powerful rig.

Argentina's Forest Area Invaded by Drilling Rig

One of the world's most powerful rigs is being used by Yacimientos Petroliferos Fiscales for deep drilling in heavily-forested areas of the Province of Salta, Argentina.

The rig has 3-section drive group powered by 8-cylinder dual fuel supercharged diesel engines through torque converters. Each of the three engines has a rated capacity of 670 horsepower.

Mud requirements are taken care of by two slush pumps, rated at 700 hp each at 65 strokes per minute. Each pump has a capacity of 955 gallons per minute with 8½-inch liners.

The draw works is equipped with a 60-inch hydromatic brake, an overrunning clutch, and a micromatic drilling control. A 140-foot derrick is used.

Although wells have been drilled in Salta Province since 1927, the first incentive for deep drilling was provided by discoveries in Campo Duran and Madrejones in 1951. The new rig, purchased in 1955, normally is considered for the 10,000 to 16,000-foot depth range. Yacimientos Petroliferos Fiscales has drilled to 12,335 feet in 150 days.

The Campo Duran and Madrejones fields are in a subtropical area. Before drilling operations can begin, access roads must be cut through the forest of the Salta Chaco, and space for the rig and equipment cleared away. During much of the year, the area is dry, but in November and December heavy rains turn the stream beds into raging rivers and bring operations to a virtual halt.

New Sicilian Oil Discovery Is Reported at Gela

AGIP Mineraria's Piana del Signore well at Gela, Sicily, reportedly has discovered an oil structure of greater significance than that discovered by Gulf Italia in the Ragusa field. It was estimated that the well would pump about 385 barrels of 10-gravity crude daily from the 10,597-11,083-foot level. AGIP Mineraria is drilling four wells in the vicinity of the reported discovery.

Also, the Coris Company has begun exploratory drilling in its Noto district concession.

Eighteen producing wells have been completed in the Ragusa field, and Gulf Italia has estimated that the producing capacity of the field will reach a yearly average of approximately 9.2 million barrels this year.

From Palerman Palermo it was reported that Enrico Mattei, president of the Ente Nazionale Idrocarburi, had decided to exploit the reported Gela discovery in an effort to convince the Sicilian Regional government that it should abolish the island's current mining law and establish a Regional Oil Monopoly for Hydrocarbons similar to the organization in the Po valley.

Italy's Crude Production Reflects Expanding Trend

During the period from Jan. 1 to Oct. 31, 1956, total Italian crude production amounted to slightly more than 3.3 million barrels as compared to almost 1.2 million barrels during the corresponding period of 1955.

The following table shows the continuing expansion in the nation's crude output during the first three quarters of 1956:

PERIOD	1956 (Barrels)	1955 (Barrels)
January-March	752,332	252,074
April-June	933,586	324,425
July-September	1,637,861	617,691
Total	3,323,779	1,194,190

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Iranian General Visits Aero

Brigadier General M. Nowtash, chief of the Iranian Geographic department and a staff officer for the Ministry of War, recently visited Aero Service Corporation, Philadelphia, with two of his staff officers. Purpose of the visit to the U. S. was to review American map making methods. Shown here are (left to right) Col. Hassein Ghodessi and Lieut. Col. Mahamad Mahdavy, who accompanied the general from Iran; Virgil Kauffman, president of Aero Service, Brigadier Gen. M. Nowtash, and Edgar Davis, one of Aero's foreign operations project managers.

Cuban Drilling Interest Shifts to Center of Island

The center of Cuban drilling interest has shifted again to the middle of the island, although this situation is regarded as temporary only. Cuban Kewanee Oil Company has abandoned its last well in the Santa Maria del Mar area, Kewanee-Jones 13, at 7985 feet, and is halting its drilling activities in Havana province for the present, according to Cuba Petroleum News Digest.

Kewanee's attention again is being directed chiefly toward the Jarahueca field in Las Villas and the Noguera Quinta concession south of Jarahueca.

Other activity in the central part of the island is represented by Consolidated Cuban's Escambray 1, which had been drilling ahead slowly through extremely hard formation. The two Catalina wells and the adjoining American Leduc 19 still were awaiting Catalina 1 testing results.

In Oriente, Cuban Stanolind Oil Company had completed its first test, and was drilling its second well, Ermita 1. Elsewhere on the island, wildcat activity was confined chiefly to Havana province. Jones-Juanita 2 was drilling below 7500 feet, and Miller-Fruehauf Oil Company of Cuba, S. A., 1 had been spudded in the small Ana Emilia concession within the City of Havana.

The latter was being drilled by the Ace Drilling Company for a new company composed of William Miller and Harry Fruehauf.

There still was no activity in Pinar del Rio save for one cable tool rig, but there were reports that Kewanee would drill a well near Mariel on a farmout from Atlantic Refining Company.

In the Bacuranao-Cruz Verde field, McCulloh Drilling Company, S. A., 1 found production, and Raul Zarraga 5 continued flowing. Cruz Verde 5 had been spudded, and Consolidated Cuban Petroleum Corporation had selected a location for Consolidated 4 test. There was no significant activity in other shallow fields.

Austrian Crude Production In 1956 Shows Decrease

The Austrian Mineral Oil Administration expects that the 1956 crude output was at least approximately 1 million barrels short of the all-time high 1955 level.

If initial estimates are correct, this would mean a decrease from 24.8 million barrels in 1955 to about 23.8 million barrels in 1956. The slow depletion of the Austrian oil fields and the continuing shortage of investment capital for the exploration of new fields were cited as reasons for the decline in production.

Professor Dipl. Ing. Gottfried Prickel, when assuming the post of dean at the Leoben Montanistic Polytechnicum, said that Austria's crude reserves "as of Oct. 31, 1957" will guarantee at least a 16-year output at the 1956 level of production.

The AMOA reported sharply increased drilling activities for the second half of 1956. Footage drilled during the first quarter of 1956 totaled 102,000 feet; during the second quarter, 210,000 feet; and third quarter, 211,000 feet.

The first postwar well south of the Danube River was spudded in during December near Kledering, whereas seismic parties have moved into such new areas as Hollabrunn and Stockerau. Nine drilling rigs were in operation early in 1957.

Bolivian Concessions Go To Pure, Standard and Hancock

Development concessions totaling 1,232,000 acres, or more than 1900 square miles, have been awarded by the Bolivian government to a group composed of subsidiaries of the Pure Oil Company, Standard Oil Company (Ohio), and Hancock Oil Company, Long Beach, Calif.

Each company will have a one-third interest in the joint venture operation, although the award was nominally made to the Andes Oil Company, Inc., a wholly-owned subsidiary of Pure Oil.

The concessions area, which is in Bolivian Oil Zone 1, is east of the Andes on plains that are about 1400 feet above sea level. The northern edge of the area is 35 miles southeast of Santa Cruz, Bolivia.

A general study of the oil and gas possibilities of the area will be undertaken before any field operations are commenced.

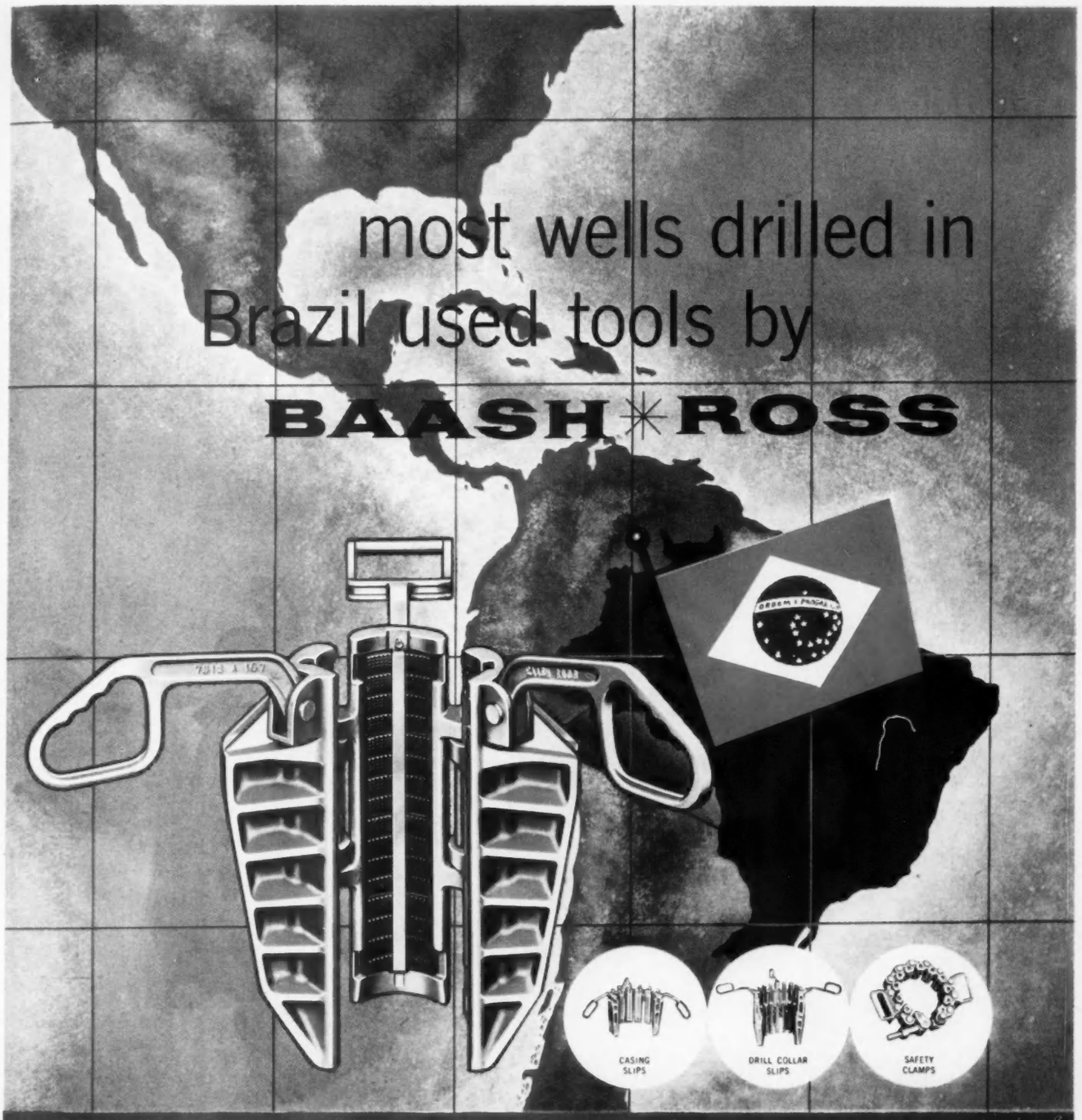
The Pure-Sohio-Hancock award is the second exploitation concession granted by the Bolivian government since adoption of a new oil code in 1955. Current Bolivian oil production is about 9500 barrels a day.

India's New Natural Gas Discoveries Analyzed

Natural gas found in India's villages of Neyppattur and Mangamadam in the Shiyali sub-district of Tanjore district, Madras State, is said to consist mostly of methane, according to the Geological Survey of India.

Analysis of the gas lends credence to the belief that the gas is derived from enclosed plant remains in the alluvium of the Cauvery delta. Drilling at these two villages has been recommended.

While there are no indications that oil may be found, the possibility has not been ruled out. Russian oil experts have held the opinion that oil could be found in the Cauvery delta.



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What's Happening

AMONG WORLD OIL MEN

JOHN B. IVEY, Denver geological consultant, left recently for Libya, where he will act as special consultant for photogeologic problems for the Oasis Oil Company.

J. B. Ivey

T. Steele

TOM STEELE, formerly editor and manager of C. O. Nickle Publications, Ltd., has been appointed director of public relations for Hudson's Bay Oil and Gas Company Limited. Associated with the public relations profession and newspaper and radio reporting and writing for 15 years, Steele began his newspaper career in Edmonton.

In 1951 he was appointed director of public relations for the Alberta Hotel Association, and two years later became public relations director of the Canadian Petroleum Association. He is a member of the Canadian Public Relations Society.

•

T. N. AMBROSE, formerly a geologist for The Texas Company in New Orleans, has joined the Cuban Kewanee Oil Company, Havana, Cuba, in the same capacity.

•

SIR FRANCIS HOPWOOD has announced intention to retire June 30, 1957, as managing director of SHELL PETROLEUM COMPANY, LTD. He will remain a managing director of SHELL TRANSPORT AND TRADING COMPANY LTD. and of Shell Petroleum Company Ltd. He also will retire as a principal director of N. V. de Bataafsche Petroleum Maatschappij.

H. WILKINSON, president of Canadian Shell Ltd., has been named a managing director of the Shell Petroleum Company Ltd. and a principal director of N. V. de Bataafsche Petroleum Mij.

Jean Ornstein Is Honored

Jean Ornstein (right), deputy chairman and managing director of BP Benzin-und Petroleum Company in Germany, receives an award from Sir Frederick Hoyer Miller. Recognition is for Ornstein's appointment as honorary Commander of the Order of the British Empire (C.B.E.) for services to the British community in Germany. Ornstein, who is French, has had 44 years' service with the oil industry, most of it with The British Petroleum group in France and Germany. After the last war he became BP's representative in Germany and managing director of the German company.

Effective June 30, IAN DAVIDSON is resigning as president of COMPANIA SHELL DE VENEZUELA, while retaining a directorship Davidson is expected to be named president of CANADIAN SHELL LTD., in Toronto, and to be named also to the boards of Shell Petroleum Company Ltd. and N. V. de Bataafsche Petroleum Mij. G.C. K. DUNSTERVILLE will be named president of Compania Shell de Venezuela, to succeed Davidson.

•

FRANK SIEGEL has been appointed division manager of Exploration, HILTON WESTMORE, division chief geologist, and A. DOUGLAS BROWN division petroleum engineer, for Sun Oil Company's Canadian Production division.

As division chief geologist, Westmore succeeds LLOYD E. MILLER, who was promoted to assistant division manager. The other two positions are new ones.

Siegel, a native of New Jersey, joined Sun in Beaumont, Texas, in 1944. He was employed in the Gulf Coast and Southwest divisions until April, 1945, when he transferred to Canada. He was in charge of geophysical operations in the Canadian division until Jan. 1, 1954, when he became assistant to the division chief geologist.

Westmore, born and educated in Winnipeg, Manitoba, was graduated with a bachelor of science degree in geological engineering from the University of Manitoba in 1942. He then served four years in the Canadian Army. He joined Sun as a geologist in July, 1950, at Calgary. For several years he has been serving as assistant chief geologist.

Brown joined Sun in January, 1953, as a field petroleum engineer.

ERRATUM

In the story appearing on Pages 186-187 of March WORLD OIL, entitled "BP Is Stepping Up Its Search for Oil Off British Coast," reference was made to the "100-ton converted corvette Seislim." This reference should have read "1000-ton converted corvette Seislim."

DRILLING HINTS

These **How-To-Do-It** Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Boom and Winch Adjust Mud Suction Line

Where earthen pits are used to contain the drilling mud and flexible suction is used, it is necessary to provide some means of raising and lowering the suction hose in the mud pit.

There are many different means of doing this; cantilevered arms, pipes spanning the mud pit and, as in the photographs above, an outrigger boom and winch.

One Gulf Coast contractor has standardized on his mud pump suction lift by building a number of "A" frames that are mounted directly on the pump skid and swing out far enough so that the end of the winch line will extend over the mud pit. This enables the operator to raise or lower his mud suction line. In transit, these "A" frames can be swung back over the pump where they can be tied down to keep from bouncing around during the move. As noted in the photograph above, the mixing pump and two rig pumps—one for standby—are all similarly equipped with "A" frame, outrigger booms with winch line and reel attached.

As you will note on the middle pump, the windlass amounts to nothing more than a piece of pipe mounted in brackets with a piece of sucker rod bent to form a handle inserted in the end with which the winch line can be wound up on the length of pipe. These arrangements provide an available lift mechanism for the suction hoses and do not have to be rigged up from one location to another. They are handy and convenient as well as being a considerable time saver when rigging up on a new location.

How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Put Vents in Doghouse For Adequate Ventilation

In most areas there is some time of the year when it is necessary to keep the change house of crew doghouse closed up. Most of these structures are just sheet steel boxes without any facilities for ventilation. This could be dangerous or at least uncomfortable especially during the cold

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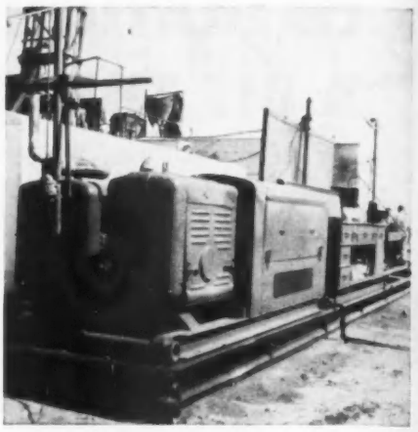
weather when a fire is kept burning inside.

A contractor who recognized this problem and did something about it solved it this way. He cut a number of slots in the wall above the door and bent them out to form louvers, as shown. As an added protection from the weather he welded a small sheet metal awning over the slots. The awning not only helped cover the slots but also kept rain from running in the top of the door.

With a little ingenuity and very little expense a real addition was made to the design of a fairly standard dog-house.



Combination Skid Is Easy to Move

This unitized service skid includes a light plant, tool box, work bench, compressor and volume tank. As the illustration indicates the entire assembly is very compact and makes an easy package to handle when it comes time to move.

On night moves this contractor does not have to wait for the arrival of the rig to begin work. This skid is spotted, flood lights run off of the light plant are rigged at each end of the unit and the work begins.

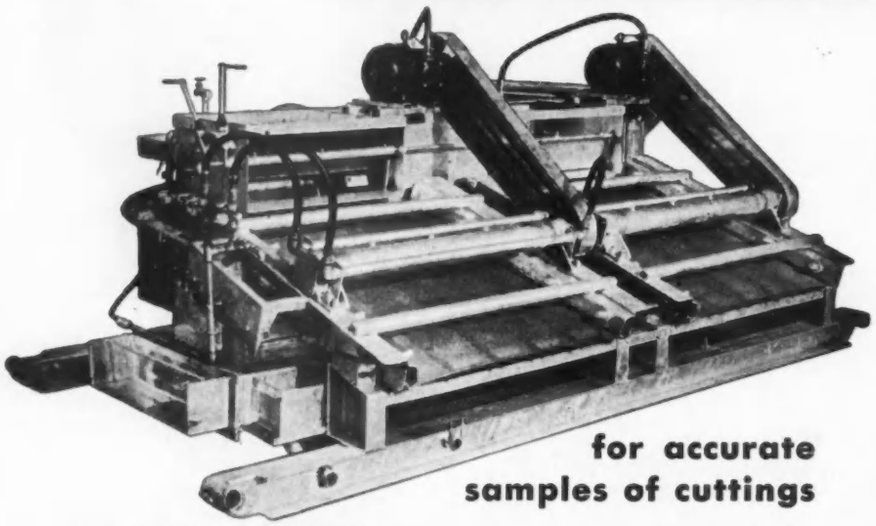
The advantages to this unit are numerous and fairly obvious to any hand who has worked on a rig that is not too well organized.

Shopmade Light Poles Save Time and Effort

It's not too difficult to find a rig where the flood lights are tied to 2 by 4's or pipe driven into the ground. Such installations rarely get the light where it is needed and the entire operation looks sloppy.

Thompson

DOUBLE VIBRATING SHALE SHAKER...and SAMPLE MACHINE



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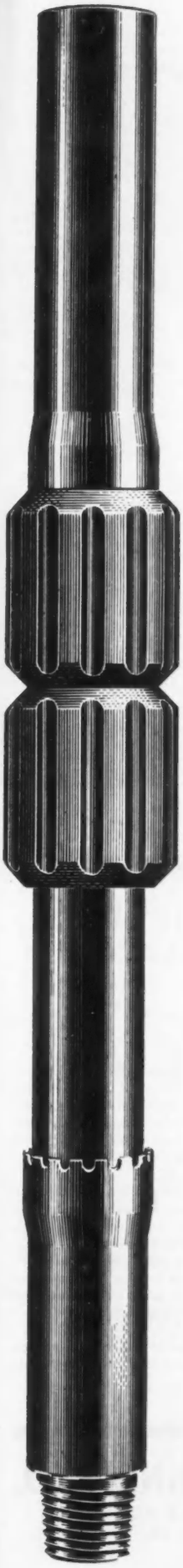

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DRILLING HINTS . . .

One contractor solved this problem with a neat, simple arrangement that provided a set location for the light poles.

Short nipples with one end of a hammer union threaded to them are welded in handy places on the rig. The 2-inch pipe light poles have the other half of the unions on their base. When it is time to rig up the lights, the poles are quickly connected to the nipple nearest the desired location.

The time and effort saved erecting the flood lights more than pays for the labor and material required to make the units.

Build Winch Line Sheaves Onto Truck Bed Corner

Where exploratory work is being carried on in rough country, a simple means of providing for emergency pulling on a stuck truck can be made by installing sheaves on the corner of the truck bed. The regular winch line is carried around one of the corner sheaves and hooked to the chassis

when in the over-the-road position. When it is necessary to pull the truck through a bad place, the line can be unhooked and run straight back to the nearest tree or improvised deadman or swung around the edge of the truck on either side and attached to the fixed object.

Chart Quotes Barrels Per Casing String

This chart tells in a jiffy the number of barrels of oil in the casing string itself, from the bottom of the well to the surface or fluid level. It will answer quickly a question that is often asked concerning that amount,

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When jobs involve depths in the medium or medium-deep drilling ranges, Bethlehem offers two rigs that are second to none. They are unsurpassed in sturdiness, low cost of maintenance, and overall efficiency. Except in size, the units are much alike, both having the same basic design.

The smaller is Bethlehem's M-58; the larger is the M-810. Here are a few of their best-liked features:

M-58 — for holes of medium depth. Outstandingly high clutch capacity; low-speed drum clutch, 59,000 ft-lb torque at 100 psi air pressure. Oversized brakes, shafts, chains. Engine compound of sectionalized type; the rig can be broken down into loads of required road widths. Choice of drives: mechanical, hydraulic-coupling, or torque-converter. Upper drum provided as optional equipment when required.

M-810 — for medium-deep holes. This rig, like the M-58, is characterized by high clutch capacity (low-speed drum clutch, 102,000 ft-lb torque at 100 psi). Powerful 52-in. brakes for extra safety. Unit can be furnished with two- or three-engine hook-up having single or double pump drive. Engine compound sectionalized. Drives: mechanical, hydraulic-coupling, torque-converter. Upper drum optional.

Either of these rigs is a sound investment. You cannot make a better buy. On the basis of cost per foot of hole drilled, their records are impressive. Ask for full details.

BETHLEHEM SUPPLY COMPANY
General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.
Canadian Distributor: Bethlehem Supply Company of Canada, Ltd. Calgary, Alberta, Canada
Export Distributor: Bethlehem Steel Export Corporation 25 Broadway, New York, N. Y.

BETHLEHEM SUPPLY

BETHLEHEM STEEL

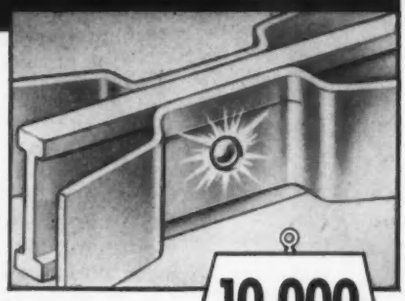
GOLD NUGGET®
WELDED
grating
PAT. PENDING

Realizing the need for an improved heavy duty, open steel floor grating of greater strength and economy, The GLOBE Company presents GOLD NUGGET Welded Grating — the first grating to take advantage of modern engineering design. As a result of this improved design, the GOLD NUGGET primary load bar provides 22% more strength with 14% less weight. The primary load bar is a miniature I-beam with all of the advantages of a true structural member.

GOLD NUGGET Welded Grating is recommended for power houses, loading docks, oil refineries, fire escapes, drain grates, plating rooms, filtration rooms and for all types of heavy duty platforms.

GOLD NUGGET

- ★ 3/16" projection weld nugget for greater rigidity and strength
- ★ vertical alignment of the main load bars assured
- ★ all bars are load carrying bars including secondary bars
- ★ anti-skid pattern



PROJECTION WELD

Each secondary load bar (A), as projected welded to the primary load bar (B) has a shear strength of 5,000 pounds per weld. There are 28 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

For the complete details of this revolutionary new grating, write for new catalog today. Distributors in all principal cities. Consult the yellow pages in your phone book under "GRATING."

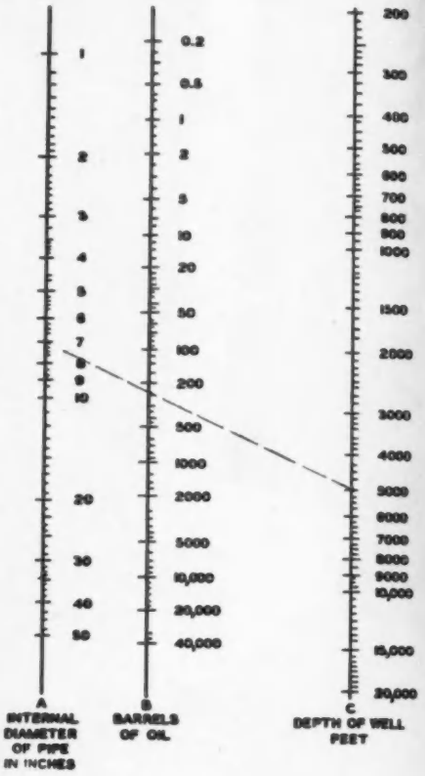
The **GLOBE** *Company* MANUFACTURERS SINCE 1914

PRODUCTS DIVISION

SAFETY GRIP-STRUT GRATING • GOLD NUGGET WELDED GRATING • CABLE-STRUT AND GLOBETRAY CABLE RACEWAYS

4008 SOUTH PRINCETON AVENUE • CHICAGO 9, ILLINOIS

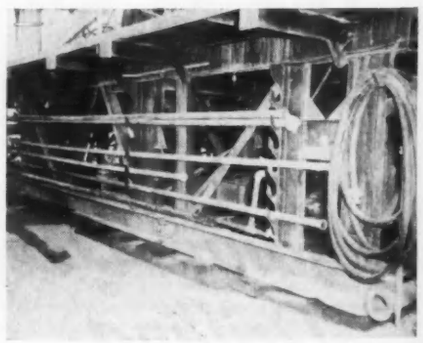
DRILLING HINTS . . .



and it does it without any figuring whatever.

It is only necessary to connect the diameter of the pipe in Column A with the depth of the well (or fluid level) in Column C. Then a line drawn between these two points will cross Column B at the number of barrels in the hole.

Example: In a 7000-foot well the fluid stands at 2000 feet. How many barrels are in the casing? The answer is 245.



Store Two-Inch Lines On Rig Substructure

One drilling contractor found out that the best place to keep the joints of water and mud lines was right on the side of the rig substructure. Accordingly, plates with slots in them were ordered welded to the substruc-

For more data on advertised products, use Readers' Service Cards, last page.

Let me tell you what MY boss thinks about...

J&L HIGH-STRENGTH CASING

We're drilling in off-shore and other deep-formation areas, so I hear a lot at the office these days about high-strength casing.

I'll tell you what MY boss thinks about J&L's N-80 and P-110.

First, he wants top strength pipe, and he likes J&L's method of heating the pipe and quenching with high-pressure injector-type nozzles.

Second, he likes the scientific accuracy with which J&L then tempers the casing to make it uniformly tough and ductile.

Third, and he says most important of all, he likes the co-operation he gets from J&L Supply men especially informed on high-strength tubular goods — men who have complete technical data on J&L seamless and can be really helpful, as in designing special casing strings.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

J&L — A GREAT NAME IN STEEL

J&L SEAMLESS CASING: Sizes from 4½" to 13⅜" O. D. Ranges 2 and 3. Grades H-40, J-55, N-80, and P-110. T & C with API threads. Buttress Thread and Extreme Line Joints also available.

J&L SEAMLESS TUBING: Sizes from 2⅜" to 4½" O. D. in T & C. Non-upset or external upset. Integral joint in 2⅜" and 2⅞" O. D. in grades J-55, N-80, and P-105.

32-S-2

ture as shown. A hook was also placed on one end to hold the high pressure hose. Whenever the rig was moved, the quick acting unions were hammered loose, the joints of pipe were placed in the rack, and then when the rig was spotted at its new location, the joints were handy for laying the water and mud lines. Where the pits were close to the rig, and not as much pipe was necessary, this was a good place to rack the excess joints of pipe, up out of the mud and handy to use when necessary.

Piece of Hack Saw Blade Acts as Light Switch

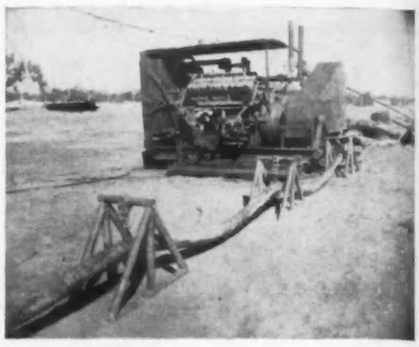
Where it is necessary to rest in the car during long hours out on the rig, it is impossible to keep the doors of the car open without having the dome light on. This attracts the bugs and interferes with the tool pusher's rest.

A short piece of hack saw blade, fastened to the upper bolt on the door switch can be turned over the switch button when it is necessary to keep the light out. When it is desired to switch the light back on, it is a simple matter to flip the piece of hack saw blade back into the "open" position as shown.

Supports Prevent Damage To Mud Line Hose

One contractor carried the idea of using rotary hose to connect up the mud pump a little farther and used it for the complete line from the pump to the rig. When the rig is on the move, it is coiled up and hung on the belt guard like a garden hose.

One of the disadvantages, however, in the use of a long mud line hose is the action of the hose against the ground when it vibrates due to the pulsations of the pump. In order to prevent this, supports as shown were fabricated in the company shop to



hold the hose up off of the ground. They are spaced approximately every 15 feet between the rig and the mud pump.

The supports are made from pieces of 2-inch scrap pipe welded into a triangle shape with a bar across the top. On the bar is connected a short piece of rotary chain with the pin removed from the bottom link. Into the space is placed a short bolt which matches with a strap placed around the mud hose. This pin is removed when the rig is on the move and is easily replaced when the supports are placed astraddle the line when rigging up. Although this seems like more trouble than laying a mud line of steel, it has proved to be quicker

OPERATOR JUST CALLED...SAID SEECO-MUL DID SUCH A GOOD JOB ON HIS LAST WELL HE WANTS TO USE IT IN THIS HOLE TOO!
"SEECO-MUL MAKES A GOOD MUD BETTER"
Garvin DRILLING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

than laying lines due to having only one connection of the mud line to disconnect and reconnect.

Mud Jet Lines Used To Support Light Post

By welding a short nipple and one side of a quick acting union to the jet lines, a place can be fixed to connect the light poles and save the job of digging a hole. Since the jet lines run around the side of the pits where the lights are needed, it puts the lights where they do the most good.

When the rig is dismantled, the posts are easily taken down and stacked with the jet lines and are ready to be hooked up again when the jet lines are laid at the new location. The entire operation can be performed and the lights connected with the posts lying down. Then the posts are swung up into the air and the unions on the jet lines tightened to hold the posts in place.

Pipe Protector, Turnbuckle Made Into Driller's Stool

A piano stool for the driller to rest on while he is running the console or feeding off drill pipe may be made from the scraps usually found around the contractor's yard. The base consists of the threads from a pipe protector with a plate welded over the end and a turnbuckle nut with one-eye screw removed is welded to the center of the plate.

The adjustable part of the stool is made by welding the bolt from the turnbuckle to a circular piece of floor plate. This part is then screwed into the top of the turnbuckle so that it can be adjusted through a foot or more of height. The lower end being round, it can be easily rolled out of the way when a round trip is being made.

use CROSSETT Seeco-Mul for better drilling... better completions-

Next time you're on a tough well, convert to a Seeco-Mul emulsion mud and watch your hole troubles disappear. Seeco-Mul makes faster drilling, reduces friction on the drill stem, provides a higher velocity of fluid on bottom, and allows pump pressures to be lowered and more evenly sustained. A Seeco-Mul mud also forms a tough, thin wall cake, it protects the pay zone from water, and reduces interfacial tension. Seeco-Mul is exceptionally stable at high temperatures, it is readily soluble in cold water, and it works well at high pressures. You will minimize hole enlargement, too, and your well will come in on production better, easier, and cleaner.

Any qualified mud engineer can use Seeco-Mul without extra equipment or special instructions. Just add it to the system (usually 2 to 3 lbs./Bbl.) through the hopper or the mud hog suction over one or two circulations. Seeco-Mul is packaged in sturdy, moisture-proof 50-pound sacks that are easy to handle around the rig.

Your local mud dealer will be glad to tell you about many other advantages of a Seeco-Mul emulsion mud, or write to us for illustrated literature and a lab sample. We'll be glad to send you full particulars without obligation. Crossett Chemical Company Division of The Crossett Company, P. O. Box 271, Crossett, Arkansas.

get a better hole with CROSSETT Seeco-Mul emulsifier

For more data on advertised products, use Readers' Service Cards, last page.

No. 4 advertisement of six proving . . .

why Jones sucker rods last longer

1. *Advanced Research and Development*
2. *Advanced Engineering Experimentation and Control*
3. *Advanced Metallurgy and Heat Treating*
4. ✓ *Advanced Manufacturing and Production*
5. *Advanced Inspection and Testing Techniques*
6. *Advanced Field Engineering and Service*

There is a

The S. M. Jones Company

ADVANCED MANUFACTURING and PRODUCTION METHODS

Each Jones Sucker Rod is precision forged after heating in high-speed furnaces. Heat treatment is carefully controlled, after which bars are descaled and shot peened to increase fatigue resistance.

Threading is done on automatic machines to close limits and A.P.I. standards. Threads are inspected with gauges which are periodically checked against A.P.I. master gauges.

A synthetic baked enamel finish is applied to protect the rods in shipment and storage.

Each coupling is accurately tapped straight through the bore and A.P.I. gauged to assure perfect make-up between coupling and rod. Coupling faces are ground while the coupling is rotating on an A.P.I. threaded arbor. Faces are always ground at right angles to the thread axis. This fine thread and ground face provide joint make-up that will assure linkage stronger than the rod.

JONES QUALITY SUCKER RODS
SINCE 1891

The S. M. Jones Company modern manufacturing plant, Toledo, Ohio

THE S. M. JONES COMPANY

●

Division of Buffalo-Eclipse Corporation

General Office and Factory:
TOLEDO, OHIO
Sales Office: Enterprise Building,
TULSA, OKLAHOMA
Export Sales Representatives:
IDECO—Division of Dresser Equipment Company, Republic National Bank Building, Dallas, Texas, and
Chanin Building, New York City

difference in sucker rods

JONES

alloy

SUCKER RODS

TYPE 12

For added strength to lift heavier loads with no increase in rod size.

Made from strong, corrosion resistant nickel chromium molybdenum processed electric furnace steel, fully normalized and drawn; has exceptionally high yield strength and excellent fatigue resistance.

SPECIFY—Jones Sucker Rods for deep wells and all wells . . . for proved longer life.

FOUR TYPES OF JONES SUCKER RODS FROM WHICH TO CHOOSE

Type	Identification	USE	DESCRIPTION	PHYSICAL PROPERTIES					
				Yield 1000 psi	Ultimate 1000 psi	% Elong. in 8"	% Red. of Area	Izod	Brinell Hardness
J-12	Protector ends painted BLUE	For heavy pumping loads under all conditions	Made from processed electric furnace steel with high yield strength and excellent fatigue resistance.	95-105	110-125	12-17	65-75	90-110	229-269
J-8	Protector ends painted BLACK	For extremely heavy pumping loads	A special alloy steel of exceptional yield strength and well-balanced physical properties.	100-115	120-135	10-15	50-60	85-85	240-280
J-7	Protector ends painted ORANGE	For medium to heavy pumping loads under all conditions	Called "standard of the industry". Strong, corrosion resistant nickle molybdenum steel, fully normalized, tempered, descaled and shot peened for further fatigue and corrosion resistance.	85-90	95-100	14-22	60-70	90-107	170-210
J-2	Protector ends painted WHITE	For medium to heavy pumping loads in non-corrosive fluids	High grade carbon manganese steel, fully normalized, descaled and shot peened to add strength and endurance.	60-75	90-105	18-24	60-70	60-90	160-210

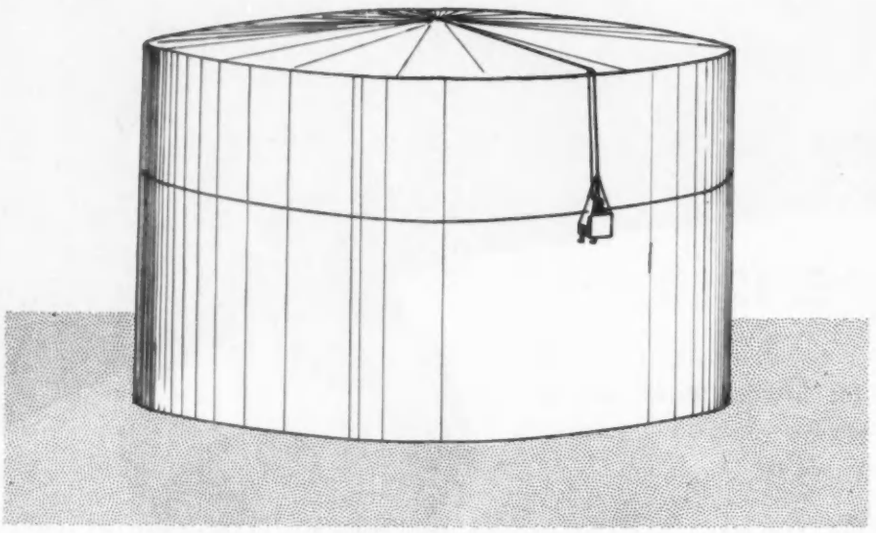
Jones Pony Rods carry the same physicals as Jones Sucker Rods. Always use proved superior Jones Pony Rods with proved superior Jones Sucker Rods.

EQUIPMENT SUPPLIERS ASSOCIATION

PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



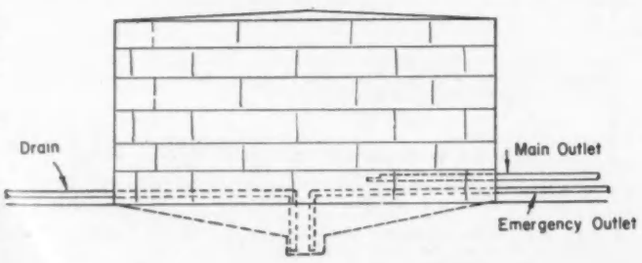
Hoist Chair on Tank Increases Safety

One major oil company has found that the use of a hoist chair, when strapping a large storage tank, has taken a lot of unnecessary danger out of the job. Further advantages for the usage of a "chair" would be (1) safety advantages over the "ladder" method and (2) position of "strapper" tends to give greater accuracy.

To put this to regular usage, the tank would have to offer the proper eyes or hooks to receive the lines from the hoist chair. However, the same hooks could be put to use on future painting jobs on the tank.

Inverted Cone Tank Bottom Adds Space

By making the bottom of a storage tank an inverted cone, more complete usage can be made of available room.



A small sump can be installed in the center for occasional use in pulling the tank completely down. In this manner, high back gages and the resulting dead storage can be eliminated and a tank might be freed for mixed usage without fear of contamination.

Baffle plates should be installed in the sump to prevent forming of a vortex during emptying. Better stripping of the tank may be accomplished by use of a small positive displacement pump.

Shopmade Volume Tank Assures Smooth Operation

With a minimum of material and labor this shopmade "surge-tank" will eliminate fuel variation in field gas supplies.

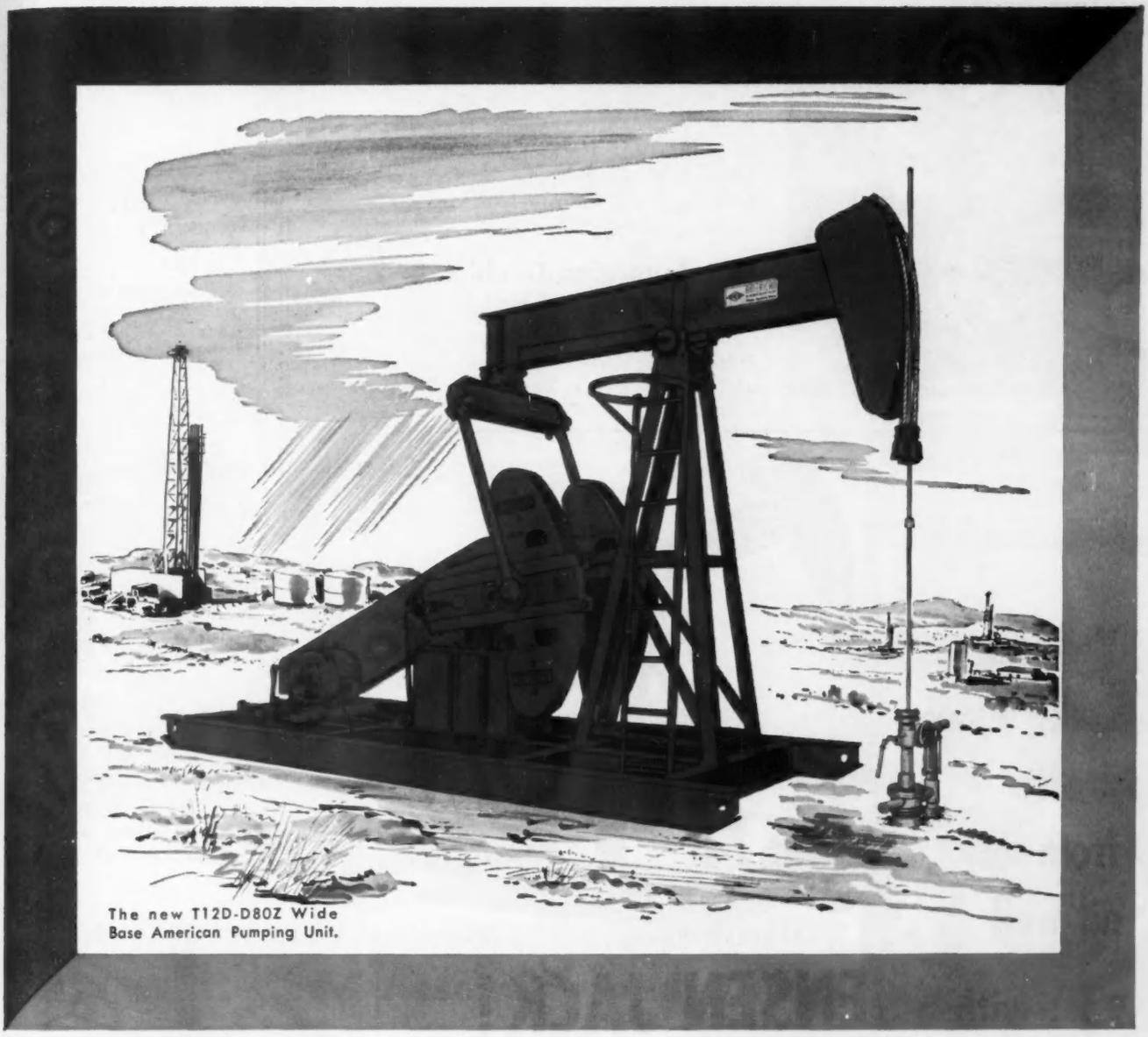
A few hours of welder's time, plus a few feet of scrap 12-inch pipe are necessary for the fabrication of this shopmade surge-volume tank arrangement.

The surge-tank allows a constant volume of gas to be readily available for usage by the field pumping unit. Customary fluctuations in pressure and volume will be more or less eliminated, and a smoother operation will be realized.

A regulator connecting the two chambers will assure the proper differential pressure between the in-

How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



The new T12D-D80Z Wide Base American Pumping Unit.

How much of your production goes for Unit Maintenance?

How many barrels of oil are you pouring back into unnecessary servicing and repairs of your pumping units? Experienced producers know that maintenance cost can be lowered with AMERICAN!

American service does not stop when delivery is made! American maintains a complete service record on all units! Every American Pumping Unit is periodically checked by trained American service crews. These trained men offer suggestions on maintenance—show you how to get even longer wear, more satisfactory service, and low-cost pumping from your American units. For prompt service contact your supply store or nearest American office.

Consider the extra years of trouble-free service that American gives—you'll find it costs less to pump with an AMERICAN. Try it!

For further information, contact your favorite supply store or nearest American office

AMERICAN MANUFACTURING COMPANY OF TEXAS
P.O. BOX 7037 • FORT WORTH

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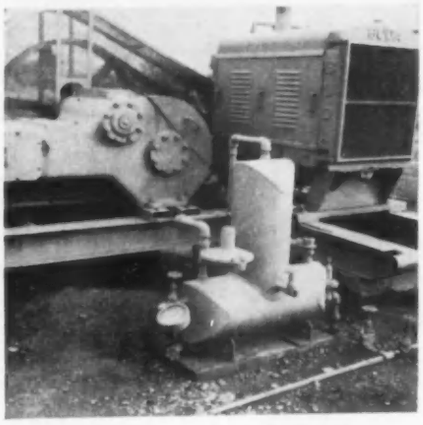
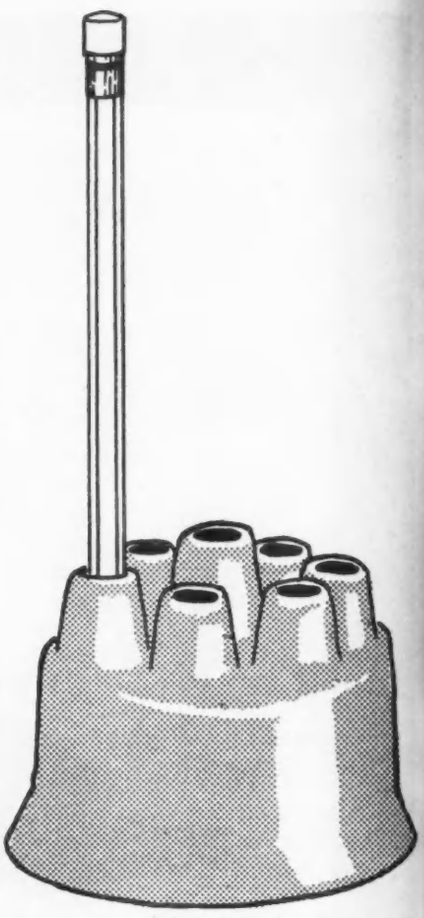


coming and out-going lines of the surge-volume tank. Draw-off valves can be installed in the lower chamber to remove condensed vapors from the in-coming gas. The out-going line is connected to the upper, or vertical tank, to assure the supply of dry gas to the operating unit.

Distributor Cap Doubles As Handy Pencil Holder

Use a discarded distributor cap to hold those pencils that often clutter up a shop table or desk. This simple, inexpensive holder keeps pencils handy when you need one, as well as improving appearance of the shop office.



You can make more profit from any oil well . . .

. . . with a JENSEN JACK!

It's a well-known fact with producers everywhere that a JENSEN JACK is likely to make any oil well more profitable . . . and this goes for yours too!

The reason, of course, is the fact that a JENSEN JACK is engineered for reliable service and economical operation. They are designed with few moving parts—practically never need servicing. One man can change the counterbalance or gear reductions easily and quickly in the field.

Let us fill you in on the other features that add to your assurance of more profit with a JENSEN JACK. See your JENSEN Dealer or write us a letter.

Stocked By Your Local Dealer

JENSEN JACKS

JENSEN BROS. MFG. CO., INC.
Coffeyville, Kansas, U.S.A.

Export Office:
60 East 42nd Street, New York, N. Y.

Weld Bent Steel to Post For Simple Gate Latch

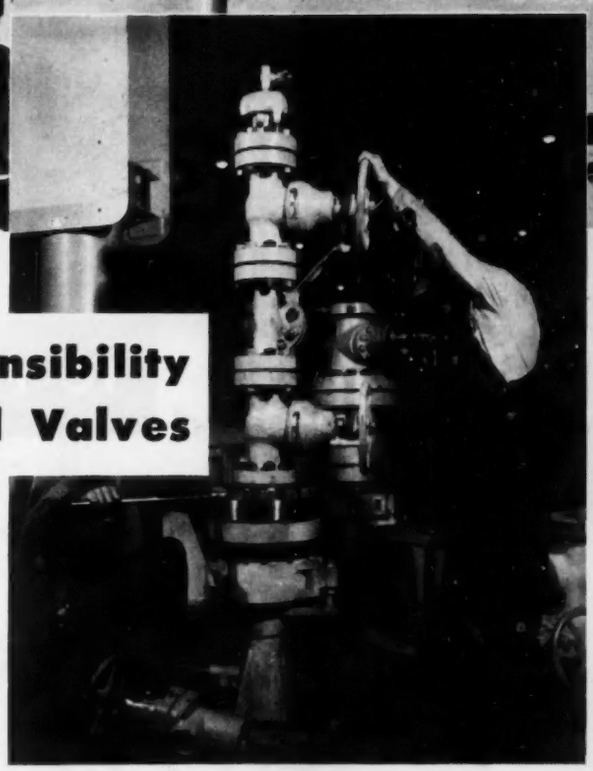
A piece of spring steel welded or bolted to the gate post makes a simple and effective gate latch.

The steel strip, bent as shown, has a small, square piece of sheet steel welded to its top which acts as a handle. When released the metal strip fits into a groove in the gate lock.

This arrangement is hard to beat for simplicity and economy.

For more data on advertised products, use Readers' Service Cards, last page.

Tested . . . and Approved



One Manufacturer–One Responsibility
BIW Well Head Assembly and Valves

The entire BIW Completion Manifold is built and tested at ALCO's Beaumont plant. Well heads, hangers, seals, the BIW non-lubricated gate valve, adjustable and positive flow controls, all are part of the complete tree designed and tested for your specific needs. The tradition and skill which back up BIW equipment go back fifty years and have been proved on thousands of wells.

Now with the resources and manufacturing experience of ALCO, you can expect BIW to be the best in safe, easy to operate, and long-lasting well head equipment. You get the craftsmanship and oil country know-how of BIW, plus the modern manufacturing techniques of ALCO.

An ALCO specialist is available to show you how the complete BIW tree and the BIW non-lubricated gate valve match up to more than meet your specifications. Or write ALCO Products, Inc., Petroleum Industry Equipment Division, Dept. BV-4, Bank of the Southwest Building, Houston, Texas.

ALCO

ALCO PRODUCTS, INC.

NEW YORK

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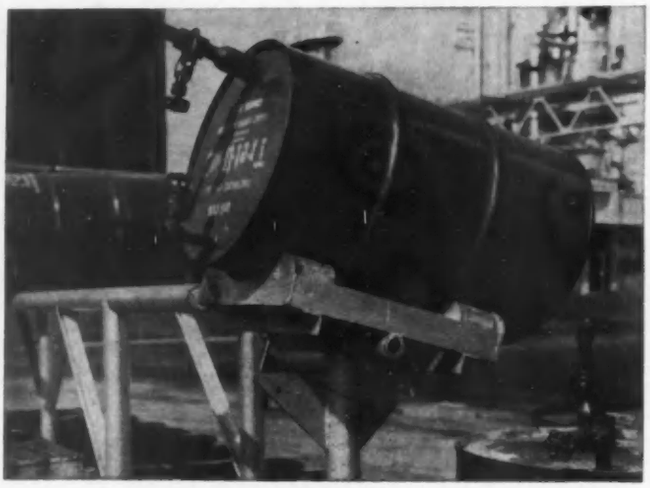
Locomotives · Diesel Engines · Nuclear Reactors · Heat Exchangers · Springs · Steel Pipe · Forgings · Weldments · Oil-Field Equipment

Slanted Rack Drains Tank of Fluid



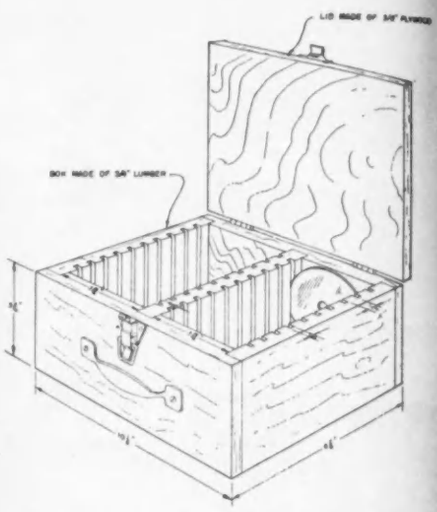
This rack can be made to any convenient height out of scrap pipe and angle iron. Load the drums with a chain hoist or a ramp and roll them down the rack to a saddle at the end.

The saddle, having a rotating capacity of about 30 degrees, will permit the emptying of all the lubricant or solvent without the usual mess and labor involved. The turning rod for the saddle is made of 2-inch pipe—the saddle being welded to the 2-inch through slots cut around 3-inch pipe carrying sleeve. The slots and a cross-brace limit the degree of rotation.

A few manhours of labor and some junk pipe will aid greatly in recovering those last few gallons of fluid usually left in a drum.

Wooden Case Protects Orifice Meter Plates

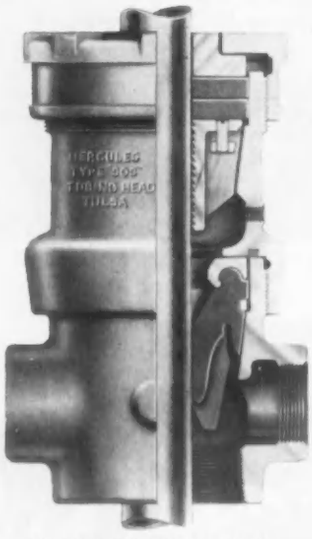
The useful life of orifice meter plates can be substantially increased if the plate face is protected from damage. To assure this protection construct a small portable wooden case like the one illustrated. It provides a clean, protected place for storing and transporting the plates.



The slotted type of construction restricts contact between the box and the plates to the outer ¼-inch of the plate circumference. It also eliminates destructive contact between the plates. Thus, the possibility of damage to the plate faces is kept to a minimum.

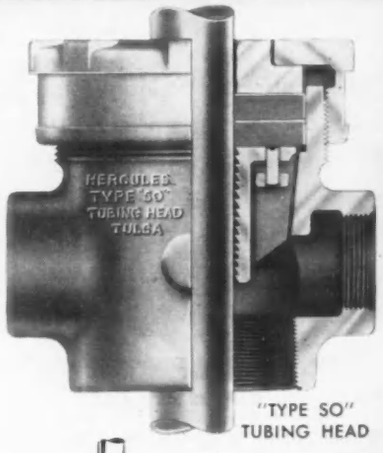
there's a Hercules tubing head

TO FIT YOUR REQUIREMENTS...



"TYPE SOS" TUBING HEAD

HERCULES "Type SO" Tubing Head is particularly suited for pumping due to compactness (only 12½" high). Stripper rubber can be used in body for running or wiping tubing. Also ideal for intermittently flowing wells.



"TYPE SO" TUBING HEAD

HERCULES "Type SO" and "SOS" Tubing Heads are the favorite of successful operators because of their simplicity, ruggedness and ease of operation. Available in 4½" OD to 7" OD Casing Sizes to suspend 2", 2½" or 3" tubing. Constructed from pressure cast steel and tested to 4,000 PSI. Slips are hinged for ease of installation and positive alignment.

HERCULES "Type SOS" Stripper Tubing Head is unsurpassed for use in well servicing operations as well as on flowing wells. It consists of a HERCULES "Type SO" Tubing Head with a bowl and Neoprene Tubing Stripper.

HERCULES TOOL Company

"MANUFACTURERS OF OIL FIELD EQUIPMENT SINCE 1924"

GENERAL OFFICES AND PLANT TULSA, OKLAHOMA

Available through all supply stores: Export Representative: Oil Field Equipment Co., Inc., 30 Church Street, New York 7, N. Y.

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Buying globe stop valves?

REDUCE WEAR, PRESSURE DROP

with Edward "streamlined flow"!

IN AN ORDINARY globe valve, sharp turns cause wear-producing turbulence and excessive pressure drop. Edward forged steel inclined stem valves with streamlined flow cut turbulence, reduce pressure drop as much as 50%. Flow is eased through the valve with no sharp changes of direction. Wear on body, disk and seat is much less, especially in higher pressure-temperature applications. Whether for steam, water, oil, gas or chemical services, Edward valves are built for long, trouble-free life. To cut maintenance costs and replacement inventories, always specify Rockwell-Built Edward Valves. They're the choice of operators all over America.

JUST CHECK THESE EXTRA EDWARD FEATURES:

- Forged steel body and bonnet!
- Stainless steel EValloy stem resists corrosion!
- Hardened EValloy stainless steel seat and disk!
- Interchangeable parts cut inventories!
- Swivel disk prevents seat galling!
- Positive backseat permits packing under pressure!
- Swing gland bolts make repacking easy!

Rockwell-built Edward forged steel inclined stem valve with *streamlined flow* . . . sizes from ¼" to 2". Ratings to 1500 lbs at 850 F, 3600 lbs W.O.G.

OILFIELD SUPPLIERS: Contact your nearest Edward oilfield representative—or write us direct—for prices and information on stocking Edward Valves. Ever-growing preference for Rockwell-built Edward Valves assures you a steady profit.

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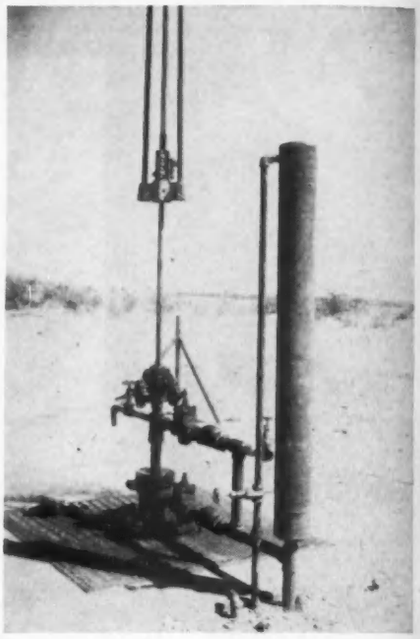
PRODUCTION HINTS . . .



Make a Volume Tank For Wellhead Gas

At times it is necessary, or desirable, to take gas from the wellhead to operate the pumping engine. When this occurs, a vessel, like the one illustrated, can be of great help. It will store a quantity of gas which will supply the engine for short periods when the well is producing stock tank oil.

The container is made of a 10-foot piece of 12-inch casing blanked at both ends. A 2-inch nipple is installed in the bottom, and a 1-inch nipple is welded near the top as shown.

The nipple is connected to a Tee in the flow line serving both the tubing and the casing. A check valve, installed in the casing line, prohibits produced oil from flowing back into the casing head.

If the volume tank is filled with gas, any additional gas produced will be delivered to the stock tanks and released.

This installation is relatively simple, not too expensive and has served its purpose well for one operator in south Texas.

Field Gas Operates Small Pump Engine

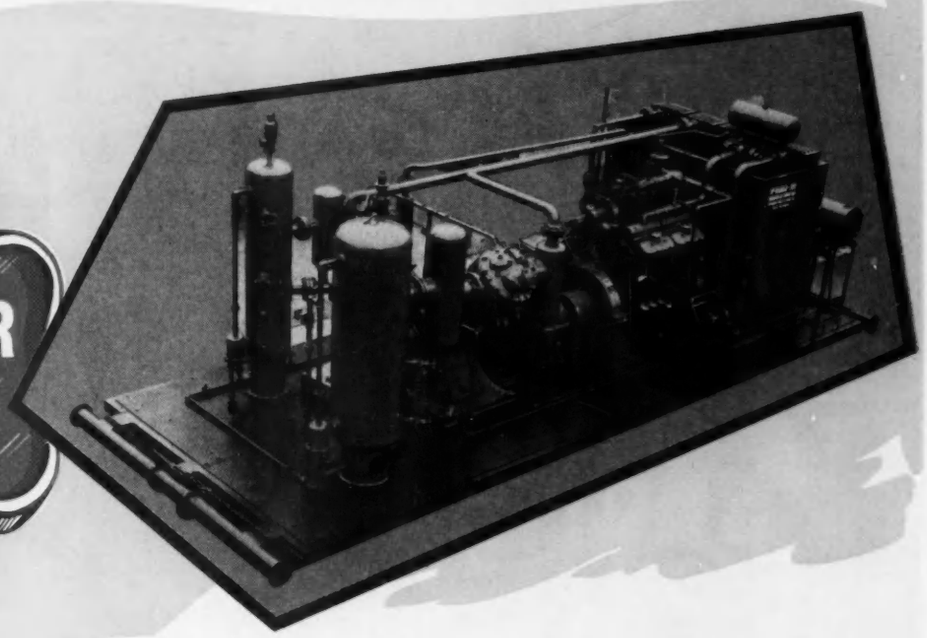
This small engine operated with field gas makes an effective power source for a small pump.

The pump is in a line to a storage

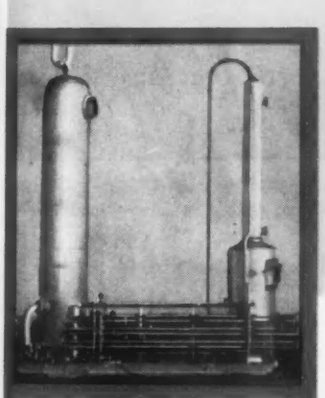
McNAMAR - JOY

for the Best in Gas Boosters

McNAMAR TULSA



● Pictured above is a McNamar - Joy WNB-112 twin cylinder gas compressor. This unit, located in the Rocky Mountains, is boosting 0.5 MMCFD gas from a suction of 15 psig, discharging at 800 psig.



McNAMAR SULPHUR EXTRACTION UNITS

McNamar's De-Sulphurization units assure dependable, economical operation and require minimum attendance. The completely packaged McNamar amine units are designed to sweeten the sour gas and make it a saleable product. Sufficient anti-corrosion measures are made to insure a longer maintenance-free plant operation.

The McNamar vertical air discharge cooler provides engine and jacket water cooling, also gas inter-cooling and after-cooling. It is a two stage, double acting, 200 horsepower compressor. The unit is direct connected through a gear reducer for minimum horsepower loss. Approximate weight is 24,000#. The overall dimensions are 7′ wide x 22′ long.

The complete unit is mounted on a single skid for compactness and ease of handling. The McNamar-Joy units are completely packaged with inner connecting piping, scrubbers, valves and safety controls and require only two connections to place in operation.

McNamar-Joy compressor units are designed to your individual applications and are available on *purchase, rental* and *rental purchase option* basis.

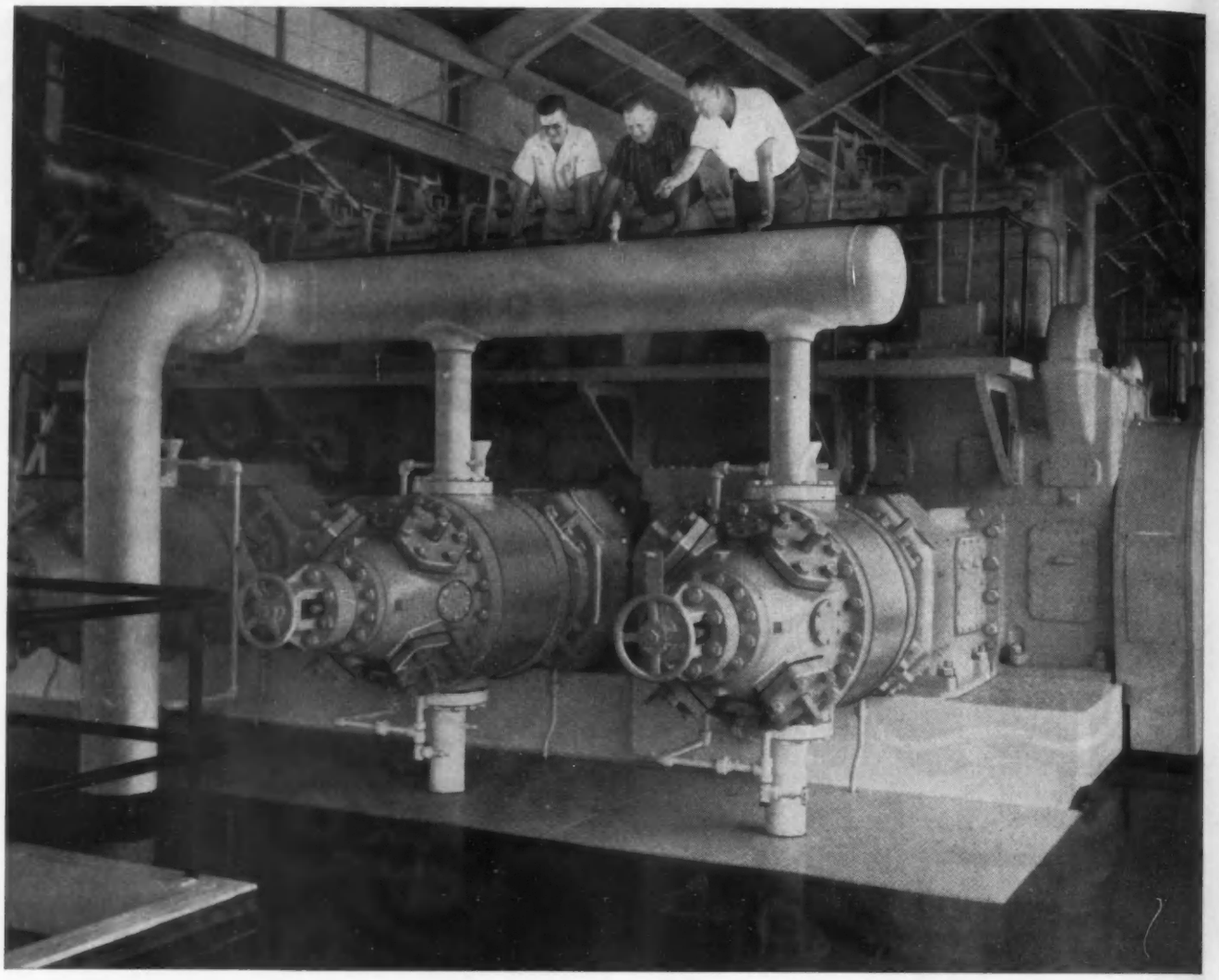
Call, write or wire McNamar for additional information.

McNAMAR TULSA

McNAMAR BOILER & TANK CO.

BOX 868 — TULSA, OKLAHOMA CHerry 2-6291

For more data on advertised products, use Readers' Service Cards, last page.



Richard N. Rogers, Results Engineer (left), W. C. Drienhofer, Station Superintendent, and R. A. Cuyler, Jr., Gulf Sales Engineer, inspect one of the 31 units lubricated by Gulf Security since 1944.

At Tennessee Gas Transmission Company's Middleton Station . . .

Not a ring change in 26,800 hours with

GULF SECURITY OIL

31 gas engine compressor units have been running smoothly at the Middleton Station with Gulf Security Oil since 1944. The records show 26,800 hours operation without a single ring change. And after 85,000 hours, Security in the crankcase was still in excellent condition.

Here for 13 years Gulf Security has lived up to its name—security against operating troubles and high maintenance costs. Gas engine compressor units lubricated with Gulf Security are consistently free of heavy port and ring belt deposits. Wear is negligible —in fact, ring and liner life in both power and compressor cylinders is well above average. Bearings last longer, too.

When you use a Gulf product you get an extra dividend—the free services of an experienced Gulf engineer. He's always "on call" to assist you with any problem involving lubricants, fuels, or any other petroleum product. Write, wire or phone your nearest Gulf office.

GULF

GULF OIL CORPORATION

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tank. When conditions require that the tank be rolled, a check valve in the gas line is opened and gas pressure starts the turbine type engine.

Both engine and pump are mounted on a piece of large size channel iron. Valves and fittings in the lines allow the unit to be removed quickly for use elsewhere should it be necessary.

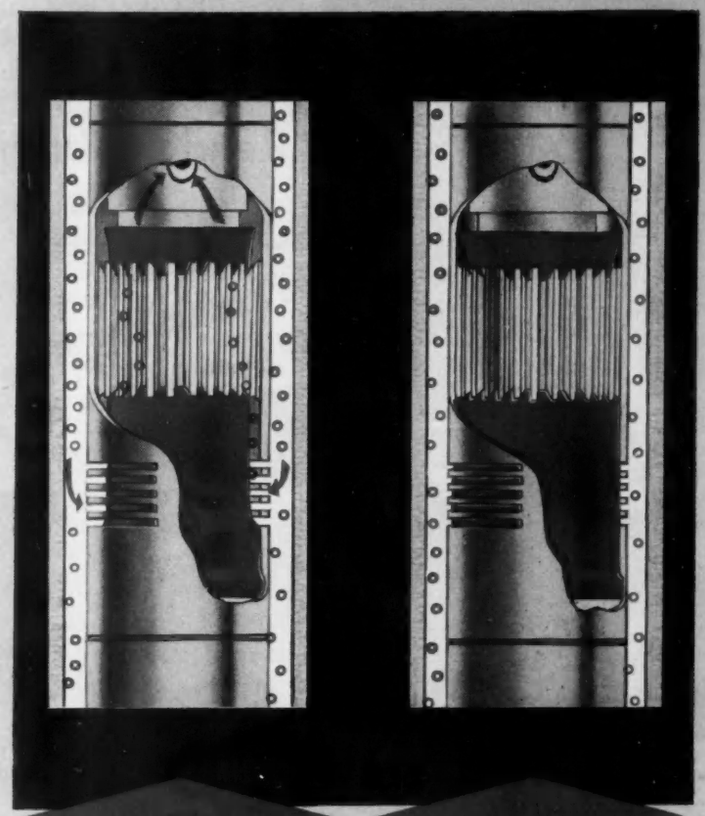
This system could be applied to a number of oil field problems where small pumps are required for intermittent periods. There is no starting problem, as is often the case with internal combustion engines. Both the initial investment and maintenance are kept to a minimum with this sort of installation.

Store Small O. D. Pipe On Shopmade Scrap Rack

This economical rack for storing small diameter pipe is made of short pieces of scrap pipe.

The base and vertical supports are made by blanking off the ends of the scrap pipe with ¼-inch steel plate.

NO METAL MOVING PARTS!
THIS RESILIENT ELEMENT



OPENS OR CLOSES

the Type C Otis Gas Lift Valve

No complex internal assemblies . . . no intricate adjustments . . . the Type C is the simplest valve you can run. The only moving parts are two resilient Hycar elements. Just two forces operate the valve — chamber pressure within the valve and casing pressure on the outside.

How the Valve Operates — When pressure in the annulus exceeds the pressure charge in the valve chamber, the valve opens. When casing pressure falls below the valve operating pressure, the valve instantly closes. The Type C is a balanced valve . . . completely casing-pressure-operated . . . controlled by the system gas, regardless and independent of tubing pressure. The resilient check valve (upper element) seals positively in the normally-closed position and does not require velocity to operate.

Type C Valves can be used for either continuous or intermittent flow — *without pulling the tubing to reset the valves.* With the Type C, there is no conversion cost to rerun a different set of valves due to changing well conditions. No inventory problems . . . one valve *as installed* will do it all.

No doubt there is a string of these valves in a well in your area. Ask an Otis man about them, or ask an operator who has run the Type C. You'll find that they are the simplest, most efficient and streamlined valves you can buy.

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Branches Throughout the Oil Country

Otis-for gas lift

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PAYNE PEOPLE GET AROUND

We must move far and fast to keep up with the ever-increasing demand for Payne Blowout Preventer Operating Units. As drilling depths go deeper on land and offshore, the need for more protection against hazardous blowouts has increased. Payne units are the only units designed specifically for the many combinations of power, volume and pressure required by the excellent preventers in use today. Any preventer closes (and opens) promptly and positively when the new fast-acting automatic Payne Pump Accumulators go to work. They use no expensive *bladders* or *diaphragms* – maintain a big 2,000 psi reserve for the safest, most economical protection available. More drilling people every month are choosing Payne reliability, and we are moving far and fast to do a better job of serving them.

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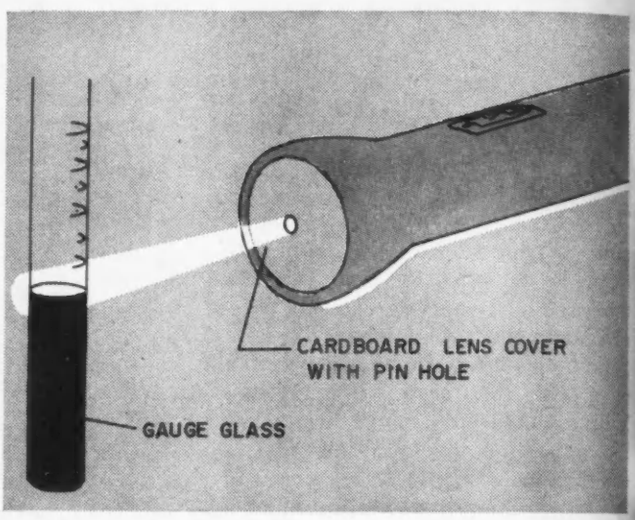
The horizontal arms supporting the stored pipe may be spaced any desired distance apart and are shorter at the top than at the bottom. This allows easy access to the stored joints.

To prevent the small diameter stored pipe from rolling off of the arms the blanking plates are extended upward as illustrated.

Read Calibration Tank Gage Tubes Easily



Here is a good idea for helping to read gage tubes on calibration tanks—especially when measuring heavy black crude.

Cut a small hole in a black placard and place the placard over the lens of any standard vapor-proof flash light. There is no need to maintain a special small beam flashlight for the job. For only 10 cents worth of material an ordinary flashlight will make a small intense beam which will serve very satisfactorily.

Stop Front Drive Wear in 2-Wheel Drive

Warn Hubs on your 4 w.d. will reduce front drive wear *in exact proportion to the miles you drive in 2 w.d.!* Watch your mileage, and you will find that you use 2 w.d. *most of the time.* With Warn Hubs, the front drive is "idle" in 2 w.d.—nothing turns but the wheels. There is no wear, no drag, no front gear whine. Your 4 w.d. has more pep, speed and power in high, and steers easier.

For maximum convenience, install Warn Lock-O-matics. They *automatically* engage the front wheels for 4-wheel drive, and disengage them for free-wheeling 2-wheel drive, *as you shift!* Warn Locking Hubs have easy fingertip controls. With either model, you'll get better, more economical service from your 4 w.d. See your local 4 w.d. dealer today. Free literature.

APPROVED MODELS FOR ALL 4 W.Ds. TO 1½ TONS

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The emulsifier for low-solids fluids. It's made with Aquaness emulsifiers, the *original* high-speed-drilling-fluid emulsifier.

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New wells are being completed faster because of longer bit life, increased penetration rates, and fewer rotating hours by the use of low-solids oil emulsion drilling fluids using Aquaness emulsifiers.

PROVED IN OVER 500 WELLS throughout the Mid-Continent areas, this fluid has been a big factor in today's trend to reduce drilling costs. It's outstanding for these advantages:

CLOSER TO GAUGE . . . less cement needed

BETTER CUTTINGS AND CORES for geological examination

REDUCED LOST CIRCULATION PROBLEMS . . . lower mud weights, less hydrostatic pressure

REQUIRES LESS SUPERVISION WITH TRIMULSO . . . the mud flows like water. Solids drop out quickly. Viscosity is easily increased or decreased.

LOOK FOR THE AQUANESS SEAL

It identifies the original high-speed, low-solids drilling fluid emulsifier, made by Aquaness for leading mud companies.

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Aquaness *Department*

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What's Happening

AMONG MEN IN THE INDUSTRY

Morgan J. Davis

C. E. Reistle, Jr.

Humble Oil & Refining Company elected **Morgan J. Davis** as their new president and chief executive officer. For the past year Davis had been serving as executive vice president. At the same time **C. E. Reistle, Jr.,** was advanced to executive vice president from the position of vice president in charge of production. **Ralph J. Schilthuis,** who has been serving as director in charge of production, was named a vice president to succeed **Reistle. Davis** joined Humble as a geologist in the old Cisco division in 1925. He advanced continually until 1946 when he was made manager of the Exploration department in addition to duties as chief geologist. In 1956 he was made executive vice president. Reistle came to work for Humble in 1936 as engineer-in-charge of the Petroleum Engineering division. In 1940 he was advanced to chief petroleum engineer. He became production department manager in 1945 and a director of the company in 1948. Schilthuis began with Humble in 1930 at the Baytown Refinery, where he was put in a student engineers' training course to study various phases of engineering. He was appointed to his present position in 1955.

Ralph J. Schilthuis

•

Dr. William E. Humphrey, geologist, has left DeGolyer and MacNaughton of Dallas after serving for almost six years as that firm's representative in Mexico and Spain. Dr. Humphrey will be associated in the future with **T. U. L. M. Corporation** and may be reached at 2204 Commerce Building, Houston.

•

P. H. Garrison has been named geophysical supervisor in the Tulsa general office of **Pan American Petroleum Corp.** He comes to Tulsa from Calgary, Alberta, where he had been Canadian division geophysical supervisor. In his new assignment, Garrison will be responsible for over-all coordination of Pan American geophysical operations in the U. S. and Canada. He joined Pan American (then Stanolind Oil and Gas Company) as a seismograph crew helper in 1939. He held various technical and supervisory positions in Texas and Louisiana, and was made Central division geophysical supervisor at Oklahoma City in 1954. He moved to Calgary the following year.

•

Dr. Alan M. Bateman, professor and chairman of the Department of Geology of Yale University and editor of "Economic Geology," has announced plans to retire in June, 1957. Dr. Bateman has been well known as a professor of economic geology and has been active in mining and petroleum matters throughout his long teaching career, which began at Yale in 1917.

•

L. G. (Lloyd) Harper has joined **Blanco Oil Co.** as assistant to **R. O. Van Fleet,** Blanco's general superintendent. Harper's last previous position was area petroleum engineer with The Texas Company at Pierce, Texas, having been employed ten years with that firm in various southwest Texas and Gulf Coast locations.

•

John Masters, head of the Calgary, Alberta, office of **Kerr-McGee Oil Industries, Inc.,** was awarded the George C. Matson Award at the annual convention of the American Association of Petroleum Geologists in St. Louis. The trophy is presented on the basis of excellence in presentation of a technical paper at the national convention. Masters' paper was entitled "Ambrosia Lake Uranium Deposit." Co-authors with Masters were **Richard T. Zitting, Fred A. Groth** and **M. Dean Webb,** all with Kerr-McGee.

•

The British American Oil Company Limited, Production and Pipe Line department, Calgary, announced the following Production department appointments. **J. S. Hart** is appointed Estevan area production manager and is in charge of all Production Department activities in the Estevan, Saskatchewan, area. **Keith S. Birdsell** and **T. C. Piper** have been appointed production foreman and assistant production foreman, respectively, in the Estevan area.

•

Rein de Wit, Calgary district geologist, will be promoted to the newly created job of senior research geologist for **Sohio Petroleum Company,** Production department. In this position he will report directly to **R. D. Roberts,** manager Calgary district; and he will conduct assigned geological research studies in the Calgary area. Also effective, **Thomas Parks,** senior geologist, will be promoted to Calgary district geologist. Parks will report directly to Roberts.

•

Brantly Drilling Company, Inc., has announced a reorganization of the company. **Thomas R. Houghton** has been elected treasurer and **Nancy D. Brantly** has been elected secretary to replace **Murphy H. Baxter** who resigned. Brantly and associates have purchased all stock formerly held by Baxter, but there will be no other changes in the organization or operation of the company.

•

H. J. Gruy and Associates, Dallas, Texas, consultants in petroleum, natural gas, and geological engineering and appraisers of oil and gas properties, announce the association of **Irene Haskett,** petroleum engineer specializing in reservoir studies. Her experience includes five years in the Production Research Laboratories of Carter Oil Company making studies of U. S., Canadian, South American and Middle East oil fields, and assisting in the development of the Carter electric analyzer. She has been employed as a reservoir engineer by Imperial Oil Company, Ltd., and Pacific Petroleum, Ltd., both of Canada, and in the Consulting and Engineering department of Core Laboratories, Inc., of Dallas.

Irene Haskett

•

Midstates Oil Corporation has named two new division managers. **Ben P. Piepgrass,** formerly manager of the San Antonio, Texas, office, has been transferred to Shreveport, La., as manager of operation in East Texas, Arkansas and the northern half of Louisiana. **V. T. Irby,** formerly assistant manager at San Antonio, has been promoted to manager of that office. The San Antonio office supervises activities in the Texas Gulf Coast and South Texas areas.

•

O. N. Miller was appointed a vice president of **Standard Oil Company of California.** Miller has been a vice president of Standard Oil Company of California, Western Operations, Inc., the company's operating subsidiary in the seven Western states, Alaska and Hawaii. Miller joined Standard in 1934 and he served as general manager of Standard's Manufacturing department for eight years, from 1946 to 1954. His experience covers both the research and refining fields, including planning and design of the Ras Tanura refinery in Saudi Arabia.

•

Canadian Bishop Oil, Ltd., has announced the addition of **Robert R. Williams** to its Calgary staff as geologist under **Rex Barnes,** division geologist. He is a veteran of five years service with the Conservation Board.

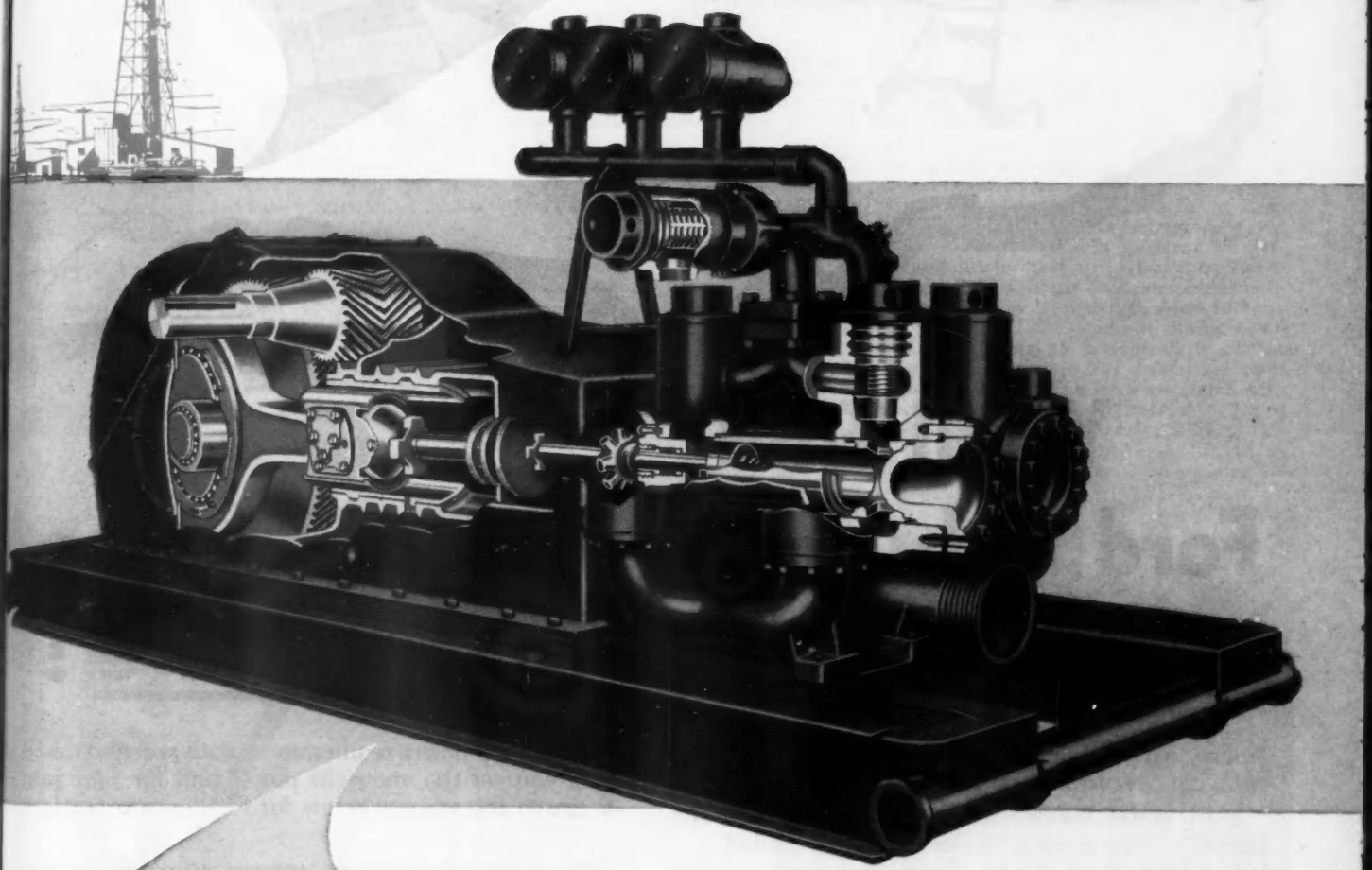
•

K. W. Brill has been promoted to assistant to **E. F. Battson,** vice president and chairman of the executive committee of **Continental Oil Company,** with headquarters in New York. He formerly was Central

There's a Reason FOR THE SWING TO

CONTINENTAL-EMSCO

SLUSH PUMPS



Here's the Picture Story

No matter what you want—more horsepower per pound, economy, ease of maintenance, automatic lubrication, "exposed" liner construction—you'll get it in the complete line of heavy duty, light weight Continental-Emsco Slush Pumps. Available in 6 sizes. Get the facts today from your nearest representative.

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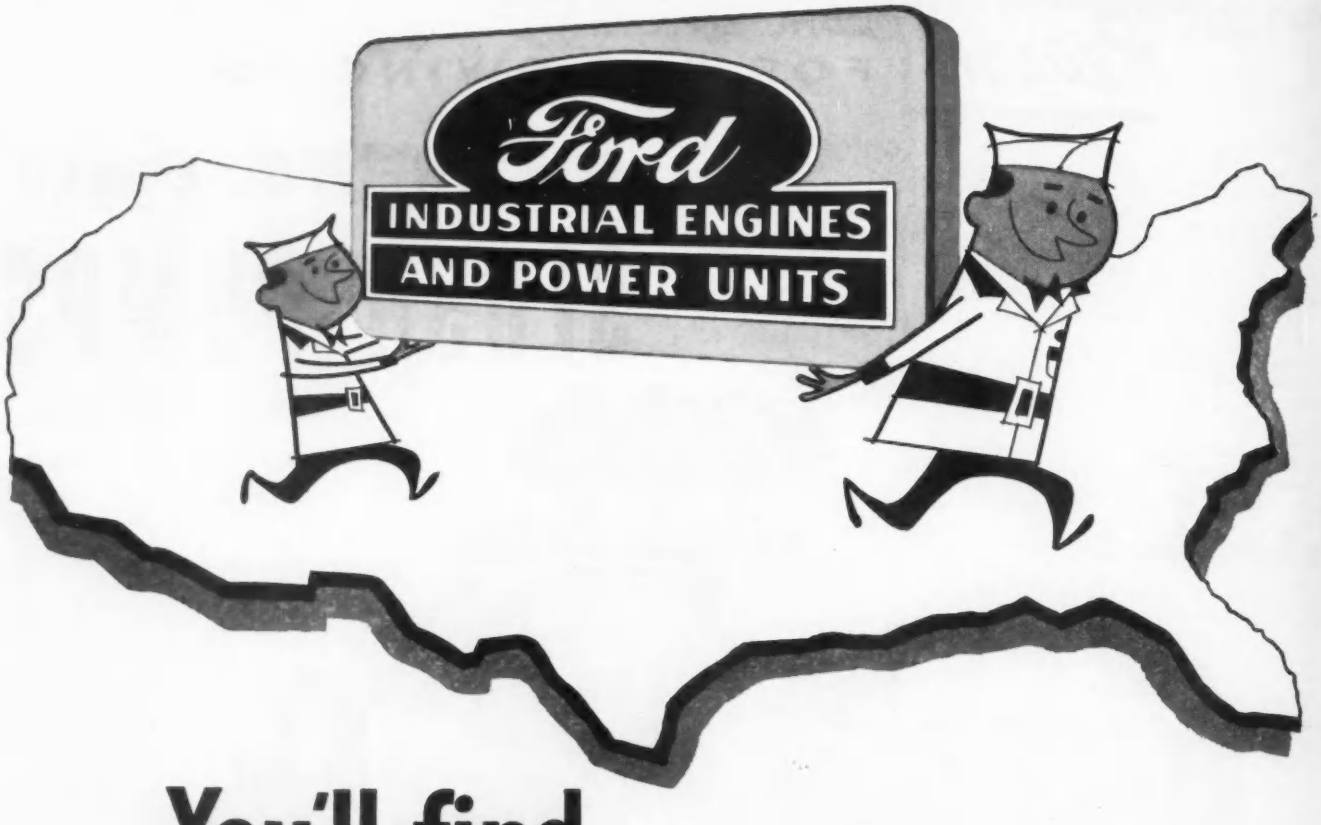
SP-702

Whether it's repair or replacement...



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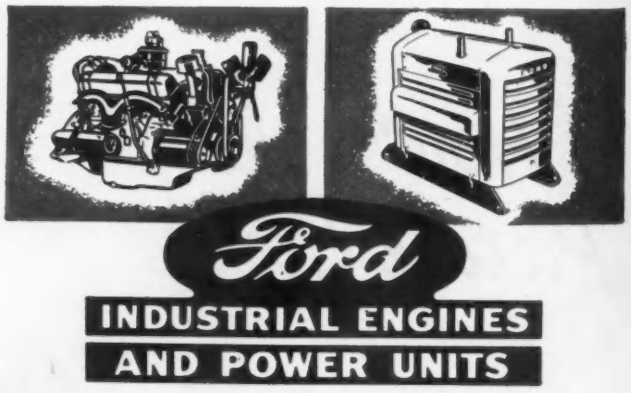
Ford power users *know* there's always a Ford Dealer nearby to give service when it's needed . . . to keep downtime at a minimum. And because Ford Dealers carry an inventory of the more commonly purchased engine parts, the Ford power user need never invest in a big parts inventory of his own.

Also, across the country, you'll find a network of newly established Ford Industrial Power Headquarters. Each is equipped to repower any type of equipment with dependable, low-cost Ford power.

It's the availability of service like this—wherever you are—that helps keep your operating costs *low*. If you are considering a new power unit or engine assembly—4-, 6- or 8-cylinder—see your Ford Industrial Products Dealer. He will be very happy to discuss your power requirements with you and make sure you get the one right power unit for *your* job. Write to the address below for further information.



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P.O. Box 598, Dearborn, Michigan

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region general manager for Conoco at Oklahoma City. Brill joined Conoco in 1930 and held a succession of key positions in the company's Land department before his promotion in 1950 to Rocky Mountain region land superintendent at Denver. He became Rocky Mountain region exploration manager the following year, assistant general manager of the Southern region at Houston in 1952 and Central region general manager at Oklahoma City in 1953.

•

Joseph D. Harnett, manager of the Transportation department since 1954, has been elected a vice president of The Standard Oil Company (Ohio). As vice president for transportation, he will continue his headquarters at St. Louis, Mo., and will be responsible for the crude oil and product transportation activities of the company, including gathering, pipe lines and marine operations. Harnett joined Sohio in 1941 as an engineer in the Transportation department. In 1944 he was assigned to St. Louis as assistant chief engineer of Sohio Pipe Line Company; in 1947, became Sohio's general superintendent of pipe line operations; and in 1954 was appointed manager of the Transportation department.

Joseph D. Harnett

Pan American Petroleum Corporation has announced two promotions in its Canadian Geophysical department. **C. A. Willner** has been named division geophysical supervisor and **M. R. Hewitt** has been appointed district geophysicist at Pan American's North Canadian district. Willner was formerly district geophysicist at the North Canadian district, and Hewitt was formerly staff geophysicist at the same office. The North Canadian district office is in Calgary, Alberta. Hired by Pan American at Stamford, Texas in 1948, Willner has served in several capacities in geophysical operations, chiefly in Oklahoma and Texas. Prior to his transfer to Canada, he was party geophysicist assigned to the Roswell, N. M., office. Hewitt was employed by Pan American in 1950 at St. John, Kansas, and was transferred to Canada in 1955.

•

Walton S. Launey, assistant Gulf Coast division geologist, **Humble Oil & Refining Company,** has been transferred from Houston to Midland, Texas, where he will serve as assistant Western division geologist. In his new post Launey succeeds **Felix Richardson,** who has become assistant division geologist in North Texas.

•

William R. Frick has been appointed assistant treasurer of Central division of **Tide Water Oil Company,** in addition to his present responsibilities as manager of state and Federal Tax department. Frick started with the company 31 years ago as cost accounting clerk at the company's east Tulsa machine shop. In 1932 he was transferred to the Federal Tax department and in 1945 he was advanced to manager of the Federal and State Tax department.

•

Louis J. Stow

Louis J. Stow was elected secretary-treasurer of **Nortex Oil & Gas Corp.** Stow succeeds **William G. Proctor,** who recently resigned. For 9 years in Dallas and 12 years previously in Philadelphia he served as supervising accountant for Lybrand, Ross Bros. & Montgomery, which he resigned to join Nortex.

•

Fred C. Boucke was appointed manager, Eastern hemisphere staff, of **Standard Oil of California.** The company also announced appointment of **E. P. Fay, Jr.,** as assistant manager. In his new capacity Boucke will manage staff services pertaining to the company's interests in the Eastern hemisphere. He has heretofore served as assistant to the vice president with responsibility for that area. He joined Standard in 1937 and has had extensive experience in foreign oil activities. Most recently he represented the company during negotiations leading to establishment of the Iranian Consortium. Fay joined the company in 1947 and has been associated with the Eastern hemisphere staff as a senior and supervising analyst since 1954.

16 S's

These Standard "S" Assemblies / Are Used for These Otis Sub-Surface Controls	Locking Assembly	Locator Assembly	Equalizing Valve	Conc. X-O Assembly	Bean Cage	Sub	Ring Check Assembly	Combination Adapter	Pack. Man. Sub-Assy.	Side Port Adapter	Sep. Tool Eq. Valve	Spacer Sub	Side Port Comb. Adpt.
1 Cross-Over Choke	S	S	S	S	S								
2 Regular Flow Choke	S	S	S		S			S	S				
3 Dual Side-Door Choke	S	S	S		S			S	S				
4 Dual Separation Tool	S	S						S	S	S	S		
5 By-Pass Side-Door Choke	S	S	S		S				S				
6 By-Pass Separation Tool	S	S							S		S	S	
7 Side-Door Choke	S	S	S		S				S				
8 Separation Tool	S	S							S	S	S		
9 Lower Zone Acidizing Tool	S	S	S		S			S	S				S
10 Upper Zone Acidizing Tool	S	S						S	S	S	S		S
11 Circulating Tool	S	S	S					S	S		S		S
12 Side Port Nipple Choke	S	S	S		S	S			S				
13 S-P Nip. Separation Tool	S	S				S			S	S	S		
14 Plug Choke	S	S									S		
15 Lower Zone } Ring Check	S	S	S		S		S		S				S
16 Upper Zone } Acidizing Tool	S	S					S		S	S	S		S

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LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....CE 5-6770
LIBERAL, KANSAS—Rainbo Service...Main 4-3598
MIDLAND, TEXAS
Luccous Service & Eqpt. Co.....MU 2-1631
NEW ORLEANS, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....VE 5-4983
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 2-3045
PETTUS, TEXAS
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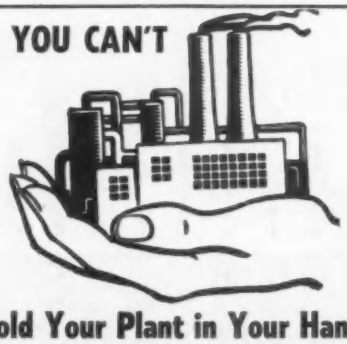
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. 2-3767, 2-8584, 3-4690

YOU CAN'T



Hold Your Plant in Your Hand

But—the Can You Hold in Your Hand Can Remove and Prevent Boiler Scale.

SAND-BANUM Pure Colloidal Concentrate

Stocked by Leading Supply Houses

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AMERICAN SAND-BANUM CO.
ESTABLISHED 1926
MEADOW BROOK NATIONAL BANK BUILDING
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Albert Gregersen has been elected vice president, **Gulf Eastern Company,** a subsidiary of the Gulf Oil Corporation. In his new position, Gregersen will be responsible for Gulf's exploration and production activities in the Eastern hemisphere, with headquarters in London, England. A veteran of long experience in the oil industry, he started his career in 1927 as a geologist with The Texas Company, and was associated with that organization in various capacities until 1945. From 1943 to 1945, Gregerson served with the Petroleum Administration for War, becoming chief of the Exploration branch with that governmental agency. He joined Gulf in 1945, in the capacity of vice president and branch manager of the Danish American Prospecting Company, a wholly-owned Gulf subsidiary, with headquarters in Copenhagen, Denmark. In 1951, he was transferred to New York and made government relations advisor for the Foreign Production division. He was given additional duties in 1952, when he was also appointed executive assistant to the vice president, Foreign Production division. Gregersen was made staff representative for Eastern Hemisphere Production, Pittsburgh general office, in August, 1955, which position he held until April 1, 1957, when he assumed his present position.

Albert Gregersen

•

I. J. Anderson, formerly division manager and geologist for Gulf Interstate Gas Company's Exploration department, has been named vice president of **Gulf Interstate Oil Company.** He joined Gulf Interstate in 1955 and had previously been district manager for Midstates Oil Corporation. Prior to that he was an assistant professor of geology at The University of Texas.

I. J. Anderson

•

Ryan Consolidated Petroleum Corporation in Dallas, Texas, elected the following directors: **James W. Aston, Jerome K. Crossman, Zellner Eldridge, Jerome Lewine, H. Neil Mallon, Vincent L. Rohloff** and **Walter Ziegler.** Crossman is the new president and chairman of the board; Ziegler is vice president; Rohloff, secretary; **Arthur S. Jones,** treasurer and assistant secretary; and **V. H. Jones,** assistant secretary and assistant treasurer.

•

Kenneth W. Paul, formerly geologist with Shell Oil Company, has joined the Houston office of **H. Zinder & Associates, Inc.,** as geological engineer. Paul has been active in exploration activities in the Permian Basin, Rocky Mountain and the Gulf Coast areas.

•

Charles F. Horton, Jr., has joined **Wheless Drilling Company,** Shreveport, La., as production engineer. He had been employed by Union Producing Company in their New Orleans and Shreveport districts since 1950.

•

Signal Exploration Company announced the election of **Arthur A. Curtice** as president and general manager. He was formerly with Conorado Petroleum Corporation. Signal Exploration is the titleholder and operator of the concessions owned by Standard Oil Company (Ohio), The Pure Oil Company, Hancock Oil Company and Signal Oil and Gas Company in Venezuela.

•

George F. Watford, Houston geologist, has been named manager of exploration for **Commonwealth Oil Company.** Before joining Commonwealth, Watford was associated with Pan American Oil Company and its predecessor, Stanolind Oil Company, for approximately nine years. He started with the firm in 1948 as a junior geologist, moved to Houston in 1951, and became district geologist for the company's Houston district in 1954.

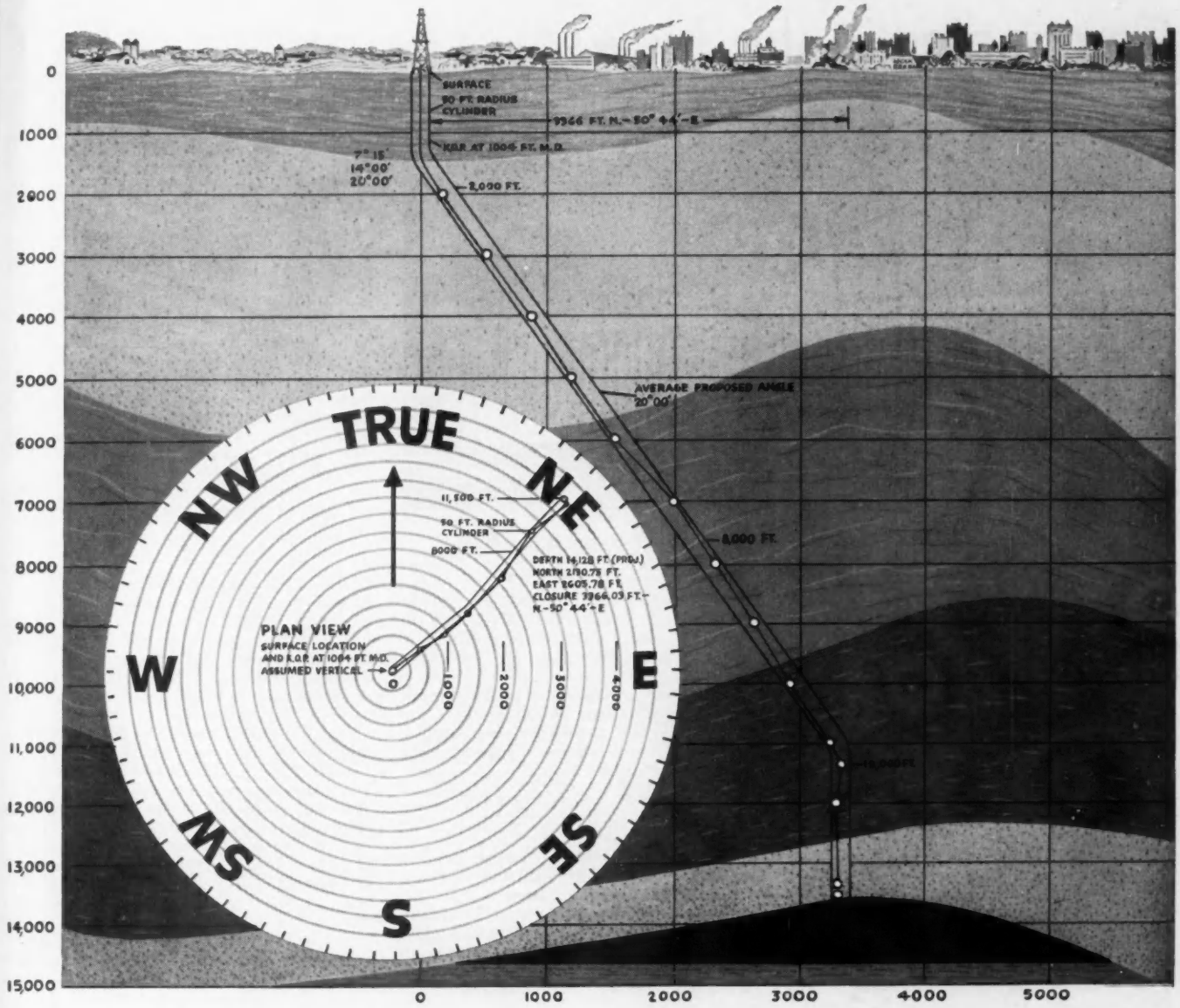
G. F. Watford

•

C. J. Stanberry has been promoted to superintendent of **Continental Oil Company's** Louisiana Production division, with headquarters at Lafayette, La. Formerly Texas Gulf Coast division production superintendent at Corpus Christi, he succeeds the late **W. J. Lueck.** It was announced at the same time that **C. A. Ward,** assistant division production superintendent, has been promoted to superintendent of Conoco's Texas Gulf Coast Production division at Corpus Christi, succeeding Stanberry. Stanberry joined Conoco in 1939 as a roustabout in the company's Tapetate field near Basile, La. He held a succession of key production positions in Louisiana and Texas before his promotion to district superintendent at Rincon, Texas, in 1949. He has been Texas Gulf Coast division superintendent for Conoco since 1955. Ward became associated with Conoco in 1926 as a roustabout in Oklahoma and held a succession of key production positions before his promotion to district superintendent at Ville Platte, La., in 1945. He was district production superintendent for Conoco at Goliad, Fort Worth and Wichita Falls, Texas, before becoming assistant division superintendent at Lafayette in 1955.

•

Bruce Lintner and **Harold Hobbs** were elected officers of **Delhi-Taylor Oil Corporation.** They will replace former secretary and treasurer **S. B. Petrie,** who has been appointed management consultant on financial affairs. Petrie has many years experience in the oil and gas industry with such companies as Humble, American Liberty, Southern Union and Delhi-Taylor. Lintner joined Delhi Oil Corporation as Petrie's assistant in 1949. He was appointed assistant chief accountant at the time of the Delhi-Taylor merger. **Harold Hobbs,** joined Continental Oil Company in Houston as a financial analyst. He was employed as administrative assistant by Delhi-Taylor in 1955. Petrie, Lintner and Hobbs each will report directly to the president and executive vice president.



Longest deviated hole

Tidewater holds it to within fifty feet of true with "K" Monel collars

Accurately bottoms 14,128-ft. well having 3340 ft. offset

This is the story of Houma I Community . . . the well with the longest deviated section ever drilled. Bottomed under Houma, Louisiana, from a location at the city limits, it was drilled for Tidewater Oil Company, using a steam rig.

The first whipstock was set at 1,018 ft. At approximately 2000 ft. the 20° drift angle was obtained and maintained closely to 8000 ft. Below that the drift angle was permitted to fall off to about 18°. From 11,000 to 12,400 ft. the hole was gradually straightened and from 12,400 to the bottom the angle was less than ½°. Ten whipstocks were used in all.

The hole is kept within a 50-ft. radius tract.

Drilling hook-up

To build angle, the drilling contractor hooked up a bit, stabilizer, and 4½-in. Servco "K" Monel* (age-hardenable, nickel-copper alloy) pup joint with 4½-in. drill pipe.

To reduce rates of change in angle or direction, he replaced the pup joint with a 20- or 25-ft. Servco "K" Monel alloy drill collar. To hold rates constant, he simply added two steel collars above the "K" Monel unit.

To reduce drift angle and regain vertical he removed the stabilizer, leaving collars in the string.

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"K" Monel prevents survey errors

Because the "K" Monel collar equipment is nearly iron-free and permanently non-magnetic under oil well drilling conditions . . . and because it isolates the instruments from magnetic influence of the string . . . survey readings are accurate. Hidden errors don't creep in.

What's more, "K" Monel stands up. It's stronger than steel; corrosion-, wear-, and abrasion-resisting.

When you drill directionally, use "K" Monel alloy equipment. It pays.

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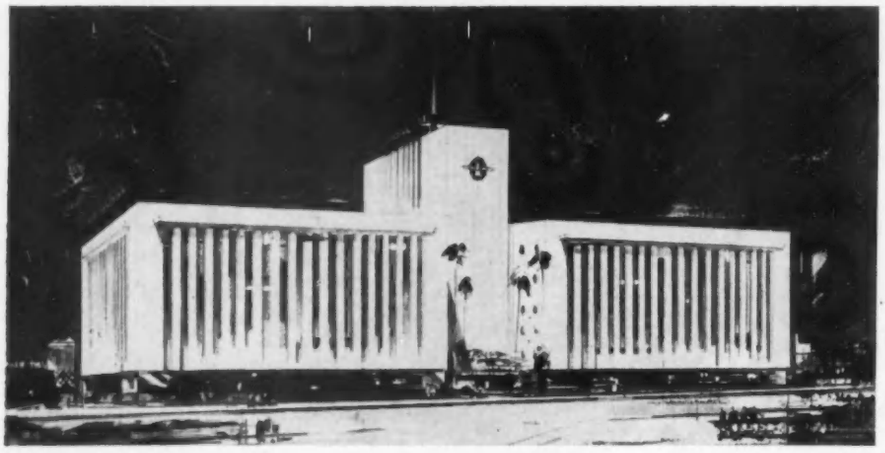
INCO Nickel Alloys

"K" Monel... *for non-magnetic drill collars*

For more data on advertised products, use Readers' Service Cards, last page.

Companies in the News



Architect's rendering of new headquarters office building for Tidewater in Los Angeles.

TIDEWATER OIL COMPANY has begun construction of a national headquarters office in Los Angeles. The $10,000,000 building will be located on Wilshire Boulevard at Crenshaw Boulevard. Completion is expected in the second half of 1958. Extending for 340 feet along Wilshire Boulevard and containing 427,000 square feet of floor space, it will be one of the largest commercial office buildings in southern California. The ultra-modern structure will have six stories with a ten story central tower. Provision will be made for later expansion of the entire building to 12 or more stories. A three-level basement will provide parking space for 400 cars. The new building will be the home office for petroleum exploration, producing, transportation, refining and marketing interests.

ETHYL CORPORATION has formed a separate Engineering department. The new department, **E. L. Shea,** chairman of the board said, will encompass the general engineering and construction coordination functions which were formerly a part of the Research and Engineering department. It will be headed by **A. C. Burdick,** as chief engineer, reporting to **B. Bynum Turner,** president of Ethyl. **G. S. Roberts,** director of general engineering, and **J. B. Rhorer,** superintendent of construction coordination, will report to Burdick. The new department was organized, Shea explained, because of the enlarged scope of the Company's research and development effort as well as the construction planning made necessary by the Company's continuing expansion program. The new departmental organization will permit integration of plant general engineering and construction functions and at the same time free Ethyl's research staff to concentrate exclusively on research and development programs. The name of the Research and Engineering department, Shea added, has been changed to the Research and Development department, under the direction of **Dr. George F. Kirby, Jr.,** Ethyl vice president.

•

KERR-McGEE OIL INDUSTRIES, INC., has established an exploration office in Calgary, Alberta, Canada. It is currently conducting a study of the geology of western Canada, preparatory to launching a program of active exploration. Heading the office is **John A. Masters,** who has been, until the Calgary opening, the company's manager of uranium exploration. He worked as an AEC geologist for two years before joining Kerr-McGee in 1953. District geologists are **Gerald C. Loucks** and **Robert L. Duncan.** Before joining Kerr-McGee this winter, Loucks was employed by Skelly in southern Oklahoma, and Duncan was southwestern Louisiana area geologist for the California Company in New Orleans. Kerr-McGee's Canadian office will concern itself only with oil exploration, and not with uranium.

•

BARNWELL PRODUCTION COMPANY and **Frank H. Harrell,** formerly vice president in charge of Midstates Oil corporation, with the purchase of a $3.5 million self-contained drilling barge have formed a new corporation, Barnwell Offshore, Inc. The principals of this new corporation are as follows: **R. S. Barnwell, Sr.,** chairman of the board; **R. S. Barnwell, Jr.,** president and director; Harrell, executive vice president and treasurer; **Morton H. Kinzler,** vice president and secretary; and **Otis Soloman,** general superintendent.

•

STANDARD OIL COMPANY OF CALIFORNIA has consolidated its marine activities into a new management organization under the name of **CALIFORNIA SHIPPING COMPANY. A. E. Kihn,** formerly manager of Standard's Marine department, has been named president and director of the new company, which will manage operations formerly handled by Standard's subsidiaries, California Transport Corporation and California Tanker Company, and by the now dissolved Marine department. Shore personnel of the three companies will be transferred to California Shipping Company; however, status of seagoing employes and the vessels themselves remains unchanged. Other directors are: **W. H. Beekhuis,** vice president, Standard of California; **H. A. Ervin,** vice president, California Tanker and California Transport; **L. C. Ford,** previously assistant manager, Marine department; **F. C. Loomis,** vice president, Western Operations, Inc., and **B. W. Pickard,** president, The California Oil Company. Ervin and Ford will serve as vice president and general manager of the Atlantic and Pacific divisions, respectively.

•

DOUGLAS OIL COMPANY announced plans recently to purchase two-thirds of the 200,000 shares of common stock of Apex Petroleum Corporation, Ltd., of Long Beach, Calif. Price named was $14.85 per share. Apex's crude reserves were put at almost 3 million barrels by **W. G. Krieger,** president of Douglas. Acquisition of Apex would more than double Douglas' crude oil reserves. Douglas expected to place privately about $3 million worth of 12-year convertible debentures to finance the purchase, and to buy remaining shares of Apex stock at a later date.

•

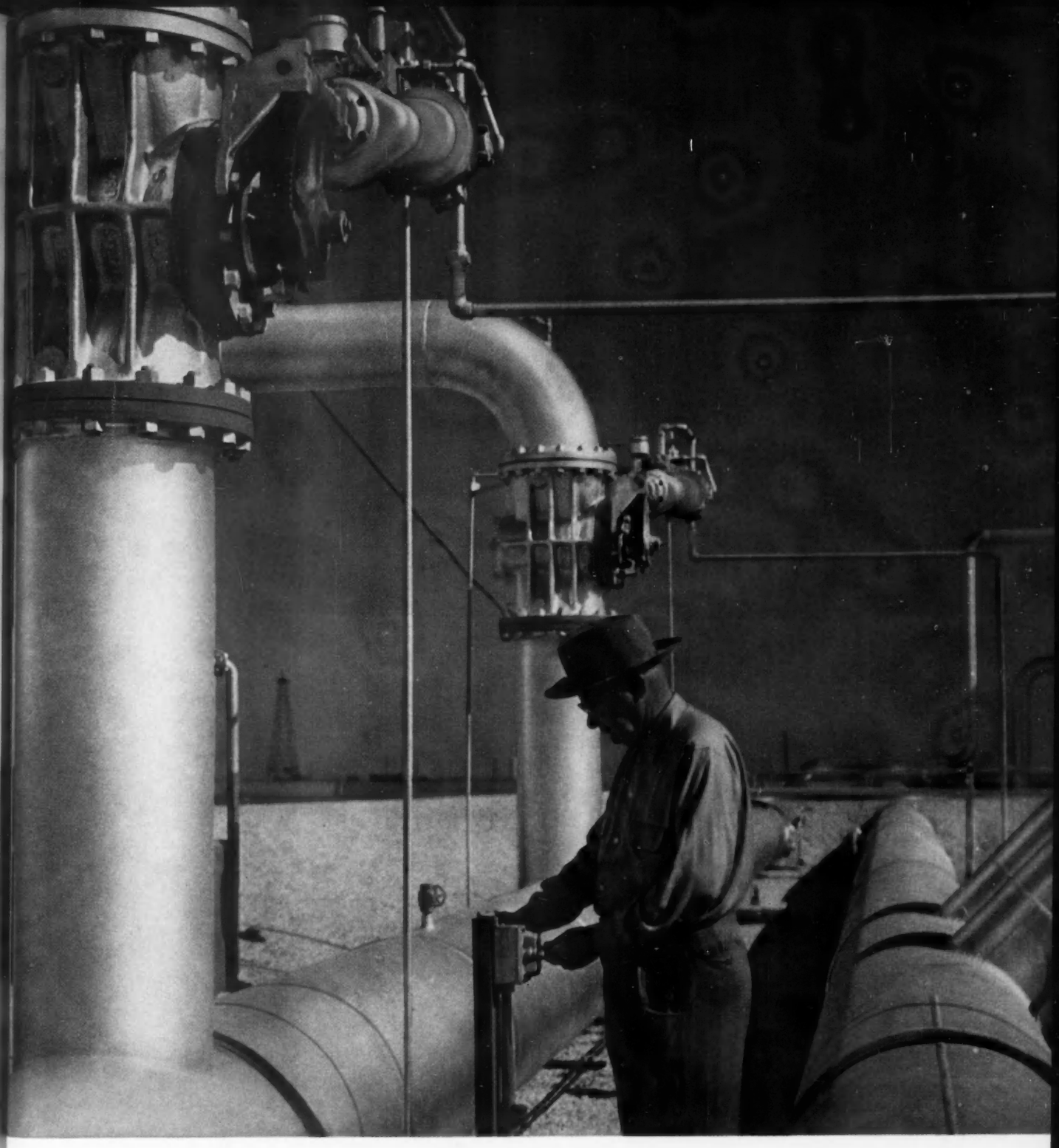
LION OIL COMPANY, a Division of Monsanto Chemical Company, plans to move the offices of personnel supervising its production and exploration operations from El Dorado, Ark., to Houston. **T. M. Martin,** president of Lion, stated that the crude oil and natural gas production and exploration operations of the company have expanded through the Mid-Continent and Rocky Mountain areas from Canada to the Gulf of Mexico. For some years Lion has had regional offices at Denver; Wichita, Kansas; Midland, Texas; and Shreveport, Louisiana, none of which will be affected by the change. "The success of oil and gas operations depends on a continuing search for new underground reserves. Lion is engaged in an intensive program of this nature and an oil center like Houston offers more opportunities for growth in both domestic and foreign operations," he said.

•

COLUMBUS REXALL OIL COMPANY of Long Beach, Calif., and Cataract Mining Corp. of New York, have concluded an agreement for the exploration and development of oil and gas concessions covering over 850,000 acres in the Province of Darien, Republic of Panama. Columbus Rexall has acquired a 50 percent undivided interest in Cataract's acreage in Panama. Columbus Rexall is an independent producer, with 23 producing wells in California, and has a wide experience in drilling all types of oil and gas wells. A field office will be established in the city of La Palma, Province of Darien, from which will be undertaken initial exploration, involving geological mapping, gravitimeter surveys, seismic surveys and paleontological interpretation, looking toward the mapping of structure and stratigraphic traps. An extensive program for the drilling of test wells on geologically proven areas will follow conclusion of exploratory work.

•

AMERICAN PETROFINA, INC., has acquired ownership of **AMERICAN LIBERTY OIL COMPANY.** The transfer includes crude oil, condensate and natural gas reserves, undeveloped leases, Amlico's Mt. Pleasant Refinery, pipe lines, marketing outlets and various other assets.



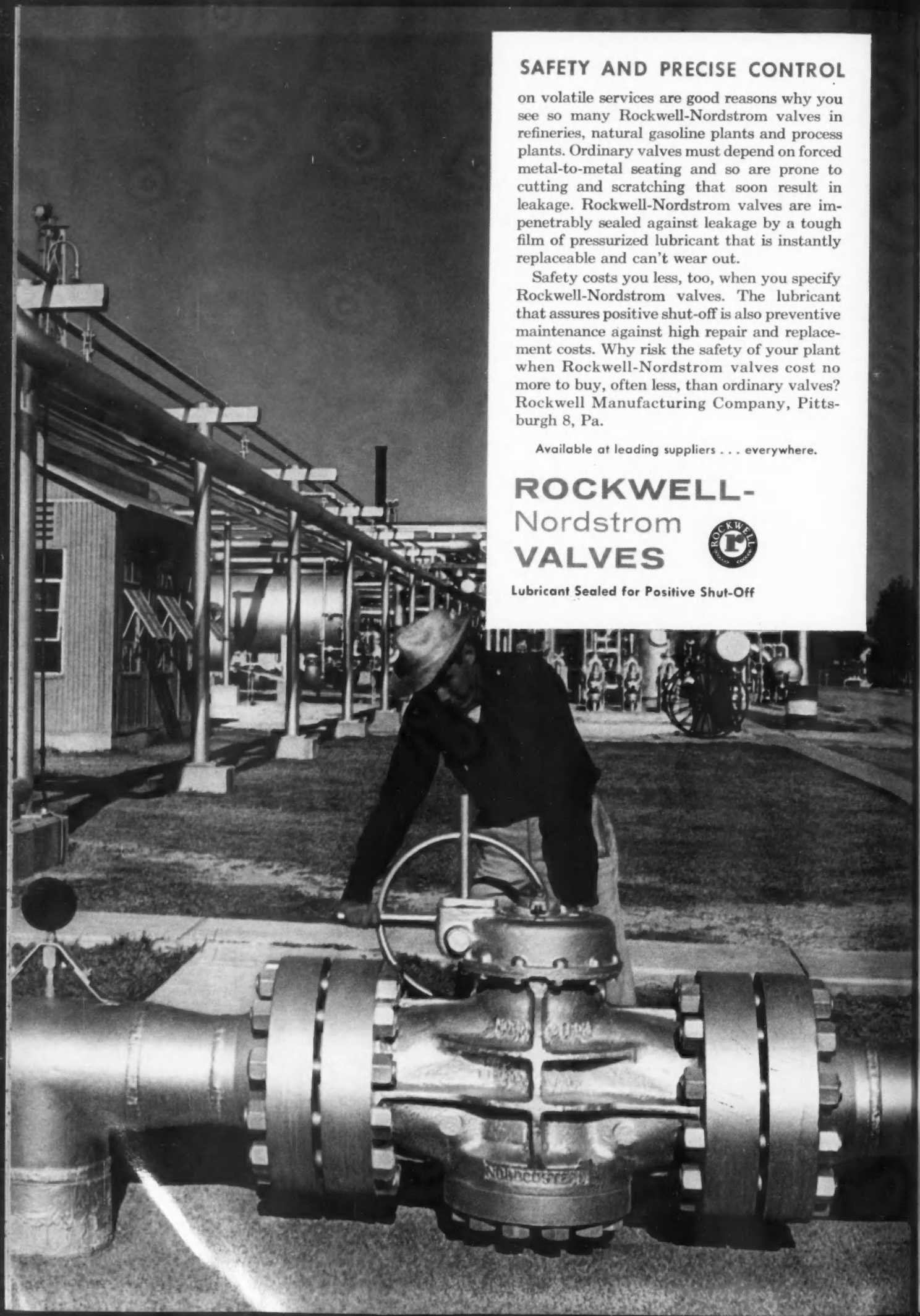
INSTANT, DEPENDABLE RESPONSE to push button or automatic flow control is assured when you specify Rockwell-Nordstrom valves. Their basic advantage for power operation that is lacking in ordinary valves: *lubrication*. Because the plug is seated on a film of pressurized lubricant, a "friction-free" surface keeps the valve ready for instant, smooth operation. And since the lubricant reduces torque and the plug is fully open or closed in a quarter-turn, a simpler, less costly actuator is needed.

Rockwell-Nordstrom valves are available in a complete range of sizes and pressure ratings with electric, pneumatic and cylinder operators. They cost no more to buy—often less—than ordinary valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed For Positive Shut-Off



SAFETY AND PRECISE CONTROL

on volatile services are good reasons why you see so many Rockwell-Nordstrom valves in refineries, natural gasoline plants and process plants. Ordinary valves must depend on forced metal-to-metal seating and so are prone to cutting and scratching that soon result in leakage. Rockwell-Nordstrom valves are impenetrably sealed against leakage by a tough film of pressurized lubricant that is instantly replaceable and can't wear out.

Safety costs you less, too, when you specify Rockwell-Nordstrom valves. The lubricant that assures positive shut-off is also preventive maintenance against high repair and replacement costs. Why risk the safety of your plant when Rockwell-Nordstrom valves cost no more to buy, often less, than ordinary valves? Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed for Positive Shut-Off

What's Happening

AMONG INDUSTRY ASSOCIATIONS

AIME Petroleum Engineers Nominees for 1958 Chosen

Nomination of Basil P. Kantzer, Houston, for 1958 president of the Society of Petroleum Engineers of AIME was recently announced. Kantzer is manager of operations of the Gulf division of Union Oil Company of California.

John S. Bell, California area manager for Humble Oil & Refining Company, Los Angeles, and E. N. Van Duzee, Midland area production manager for Shell Oil Company, were announced as 1958 vice presidential nominees.

Should no additional nominees be offered, all three of these men will assume office in February, 1958.

Nominees for the Society of Petroleum Engineers Executive Council for 1958 are: R. A. Morse, associate director of research for Gulf Research and Development Company, Pittsburgh; Harry D. Campbell, president and general manager of Franco Western Oil Company, Bakersfield, Calif.; Roy A. Bobo, director of drilling engineering division for Phillips Petroleum Company, Houston; Raymond E. Howard, regional petroleum engineer for Atlantic Refining Company, in the West Texas-New Mexico area, Midland, Texas; and Byron L. (Barney) Francis, assistant to the division manager of The California Company, New Orleans.

OIC Picks Representatives For New York, Southeast

Appointment of two new district representatives in the New York and Southeastern district offices of the Oil Information Committee of the American Petroleum Institute was announced.

William A. Scott, Jr., has been named district representative in the New York-New Jersey district, and Carl R. Lowendick, of Decatur, Ga., has been named district representative in the Southeastern district.

Scott came to the Institute from United Medical Service, with whom he had been a field coordinator. Lowendick had extensive experience in sales and personnel work before joining the API.

Houston Petroleum Club Picks Butler as President

Newly elected directors of the Houston Petroleum Club took their first official action in selecting the club's officers for the 1957-58 administrative year. Taking office immediately as president is J. R. Butler, a partner in Butler, Miller & Lents, consulting petroleum engineers and independent oil operators.

Butler succeeds Michael T. Hallbouty, also a consulting petroleum engineer, geologist and independent oil operator. The new president has been active in oil industry programs for several years, serving with independent oil men's organizations and associations.

Other officers named are Sidney A. Adger, first vice president; A. L. Selig, second vice president; Howard C. Warren, secretary; Joseph B. Kennedy, treasurer and Walter G. Sterling, assistant secretary-treasurer.

New members of the 11-man board are E. D. Brockett, Warren, Kennedy and Sterling.

Colorado RMOGA Post Goes to Veteran Journalist

Earl Wennergren, Denver newspaper and public relations man, has been appointed Southern division manager for Colorado of the Rocky Mountain Oil and Gas Association. He succeeds Bill Ballin who has resigned to accept a position in the Public Relations department of the Ohio Oil Company at Findlay, Ohio.

Wennergren

Wennergren formerly was a feature writer for the Rocky Mountain News. For the past year he has been public relations director of KLZ Radio and Television station in Denver. He also has some 12 years experience in the newspaper and public relations field, including nearly three years in the Publicity department of the Columbia Broadcasting System in Hollywood.

Log Interpretation School Set for June 3 in Denver

Dr. S. J. Pirson and Jack Grynberg are conducting the third two-week extensive and intensive course in quantitative electric log and radioactivity log interpretation, and in dipmeter computation. This course, offered to both geologists and petroleum engineers, is limited to ten persons. It will be conducted in Denver from June 3 to June 14 inclusive, for a total of 80 hours of personalized instruction and supervised log analysis work by experienced teachers.

Besides the conventional techniques of quantitative log interpretation, instruction will also be given in the newer methods of predicting well productivity and recovery in the various types of reservoir rocks such as those of intergranular porosity in clean and shaly rocks, whether water-wet or oil-wet, and in rocks of multiple types of porosity such as in carbonate and in fractured rocks.

Registration or request for further information should be addressed to Jack Grynberg and Associates, P. O. Box 4279, Denver 9, Colo.

Drilling Leader Named To National Oil Post

Jack H. Abernathy, president of the American Association of Oilwell Drilling Contractors, has been named a member of the National Petroleum Council's Committee on Petroleum Productive Capacity. Abernathy is vice president of Big Chief Drilling Company, Oklahoma City.

The special NPC committee was formed

PUMPING PROBLEMS SIMPLIFIED

with DARCOVA composition valve cups

DARCOVA valve cups are *the* truly texture-engineered cups that give you exactly the right composition for maximum pumping efficiency and cup life under varying conditions of depth, pressure, temperature, corrosion and abrasion.

Darcova valve cups are available in a complete range of sizes *and* types for your job, and assure maximum production with minimum down-time.

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DARLING VALVE & MANUFACTURING COMPANY

DARCOVA ®

THE ORIGINAL COMPOSITION CUP

WILLIAMSPORT 28, PA.

For more data on advertised products, use Readers' Service Cards, last page.

at the request of H. A. Stewart, director of the U. S. Interior Department Office of Oil and Gas, to "ascertain the facts and report to the Council the productive capacity of the U. S. for crude oil and natural gas liquids as of Jan. 1, 1957, by the principal producing areas of the U. S."

Young Is District Chairman Of Mid-Continent API

E. E. Young, Sohio Petroleum Company, Oklahoma City, was elected district chairman of the Mid-Continent district of the Division of Production, American Petroleum Institute, during the spring meeting in Tulsa.

The new district chairman succeeds F. F. Wright, Sinclair Oil and Gas Company, Tulsa, and will serve one year. The other new officers are: J. T. Nutter, Midstates Oil Corp., Seminole, vice chairman for the Seminole-Oklahoma City area; James W. Rockhold, petroleum consultant, Great Bend, Kansas, vice chairman for Kansas; Charles P. O'Loughlin, O'Loughlin Well Service Co., Perry, vice chairman for the Drumright-Perry area; Fred J. Neslage, West Pampa Repressuring Association, Pampa, Texas, vice chairman for the Texas Panhandle; J. A. Maurer, Mack Oil Co., Duncan, vice chairman for the Southwestern Oklahoma area; Gene Bates, The Texas Company, Maysville, vice chairman for the Golden Trend area; John Terry, Lane-Wells Company, Oklahoma City, secretary-treasurer; and F. F. Wright, Sinclair Oil and Gas Company, chairman of the district advisory committee.

Also D. L. Connelly, Warren Petroleum Corporation, Houston, and vice president of API for production, presented "Citations for Service" to: D. L. Trax, Topeka, Kansas; Neslage; J. H. Field, Sohio Petroleum Company, Oklahoma City; Ross Bolton, Crescent Corporation, Tulsa and L. E. Fitzjarrald, Phillips Petroleum Company, Bartlesville, Okla.

Ralph Harvey Is President Of NTOGA for 1957-58

Ralph O. Harvey, Jr., has been elected president of the North Texas Oil and Gas Association for the fiscal year 1957-58. Other officers are R. J. Moran, first vice president; James M. McCutchen, second vice president; George W. Anderson, Jr., executive vice president. The Association has offices at City National Bank Bldg., Wichita Falls, Texas.

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COUPLINGS
FOR OIL COUNTRY USE

TOP QUALITY Since 1918

LINE PIPE COUPLINGS A.P.I.
⅛" to 12"—Seamless and Special Processed—Black or Galvanized

PLAIN TUBING COUPLINGS A.P.I.
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REAMED AND DRIFTED A.I.S.I.
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DRIVE PIPE COUPLINGS
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Erie, Pa.—R. J. Maggi, Box 711
Falmouth, Mass.—Walter S. Bennett, 53 Minot St.
Grand Rapids, Mich.—R. W. Lang, Jr., 138 Burton SE
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Milwaukee, Wisconsin—W. G. Nelson Co., 3347 N. 97th St.
Narberth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Ira L. Rothenberg & Assocs., 398 Market St.
New York, N. Y.—Max Rothenberg, 11-05 38th Ave., Long Island City
Omaha, Nebraska—Wm. Freiden, Central States Engineering & Sales Co., 5101 Blondo St.
Oswego, N. Y.—Northeastern Associates, Neil Chatterton, Secy., P. O. Box 284
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., 15 E. Franklin St.
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DEATHS

G. Stewart Brown, 50, manager of the Public Relations department of Standard Oil Company of California, died April 12 at his home. A veteran newsman and public relations executive, he had in recent years been prominent in petroleum industry affairs, serving as head of the nationwide Oil Industry Information Committee in 1955. He had been head of Standard of California's Public Relations department since 1945.

R. H. Reynolds, 70, retired oil drilling contractor, died April 13.

Hugh A. L. Halff, 53, president and treasurer of Blanco Oil Co. died April 14.

Stanley G. Elder, 52, Sun Oil Company regional geologist, died in a Tulsa hospital April 11. Elder was a Sun employe for 20 years.

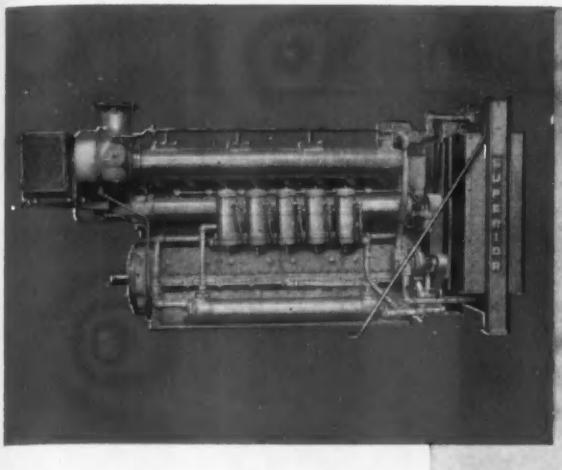
Robert Rushing, 37, an engineer for Sinclair Oil Company died April 10 in a Tulsa hospital. Rushing joined Sinclair four years ago. Earlier he was with Skelly Oil Company.

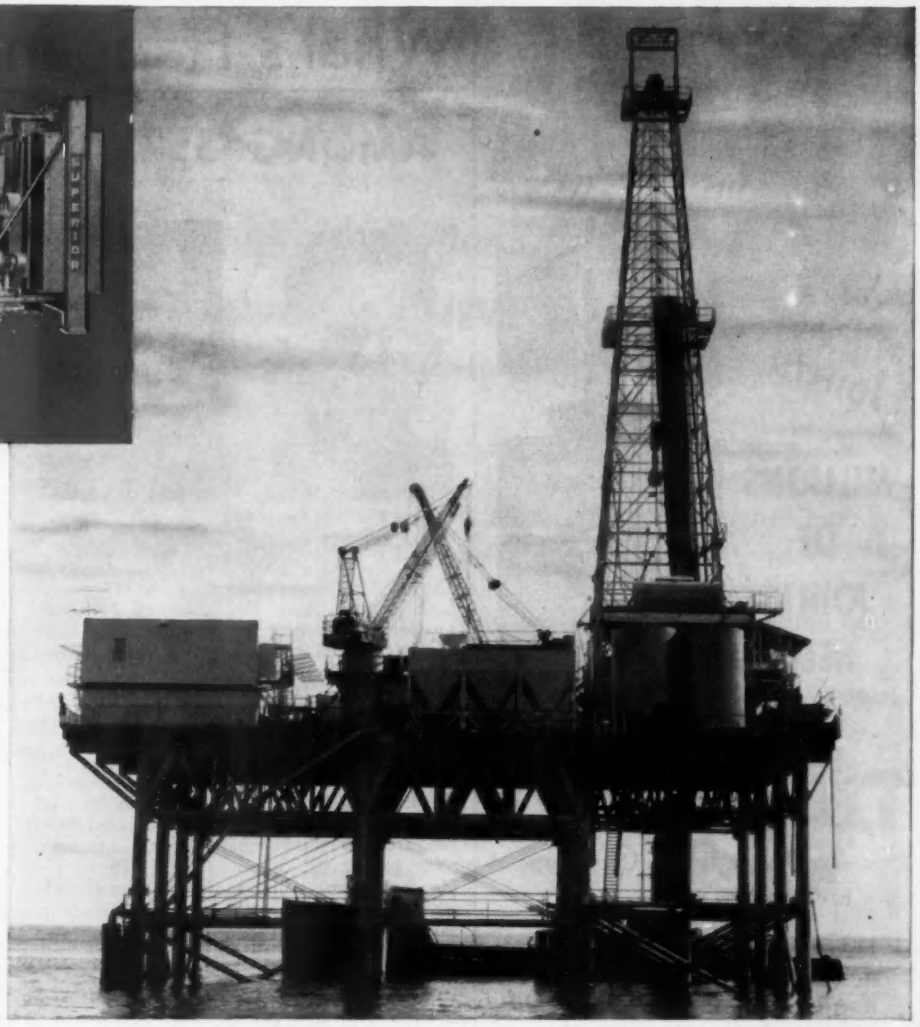
George C. Terry, 57, retired oil executive died April 2 in Los Angeles. Terry is credited with the discovery of a new field in Ventura County five years ago.

Herman Aweas, 54, vice president in charge of drilling for Helmerich & Payne, Inc., died April 4. Aweas, also a vice president of White Eagle Oil Company, parent firm of Helmerich & Payne, joined the firm as a field mechanic in Illinois 23 years ago. He was transferred to Tulsa about 14 years ago as manager of drilling operations.

Charles H. Burton, 64, president of the old Burton-Springfield Oil Company, a Carter Oil Company employe and an independent oil man before going to work for Douglas Aircraft as inspector five years ago, died April 4.

William Lee Larkin, 85, retired oilman, died March 29 in a Tulsa convalescent home after a long illness. He was an oil lease dealer and oil producer before he retired.





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SHORELINE'S RIG 7 DRILLS TO SUPER-DEPTHS

Tremendous depths, restricted only by present drill pipe and drilling methods, are reached by Shoreline Drilling Company's new Marine Rig 7, located in the West Delta Area off the Louisiana Coast. For prime power on this isolated Gulf platform, where drilling is being done for the CATC Group, Shoreline wisely chose three White PTDS-8 Supercharged Superior Diesels, each rated at 800 B.H.P.

Greater operating economy and dependability with White Diesels assure more profitable and continuous development drilling. Moreover, the up to 30% power increase in the newly improved Super PTD's gives greater working ability, more lugging power and faster acceleration. Yet engine size is not increased, resulting in less weight and less cost per horsepower.

Many other new design and engineering features make White Diesels outstanding for rugged, efficient, low-maintenance service. Superior Diesel, Dual Fuel or Gas oil field engines are available from 320 to 2150 B.H.P. Get the facts from leading rig manufacturers, White Diesel representatives in oil field areas, or the White Diesel Engine Division general office.

White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY

Plant and General Offices: Springfield, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

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Heat-proof, vibration-proof, non-solvent, non-shrinking, non-crumbling, non-cracking . . . for every gasketing and sealing requirement. Makes all assemblies leak-proof and pressure-tight. Withstands heat or cold, high pressures, oils, gases. Prevents rust, corrosion, and seizure of joints.

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Loosens Rusted Bolts, Nuts, Parts

A powerful blend of quick-acting, super-penetrating solvents. Frees parts frozen by rust, corrosion, scale, paint, varnish, carbon or gum.

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RADIATOR SPECIALTY CO.

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CHARLOTTE, NORTH CAROLINA

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What's Happening

AMONG SERVICE AND SUPPLY MEN

J. E. Smith

Harry E. Hester

Ramon I. Lindberg

Everett P. Carley

J. E. Smith, vice president of Johnston Testers in Houston since 1951, has been named president of the **Hutchison Manufacturing Company** of Houston, it was announced by F. E. Hutchison. The latter organized the Hutchison Company 20 years ago and will be chairman of the board in the new management setup. With Smith as president, Hutchison will devote the bulk of his time to development and engineering. Smith became associated with Johnston in 1938 when the testing company purchased the Gas Lift Corporation. He has been sales manager since 1951 when he was named a vice president of sales and engineering. His title was changed to vice president of sales and advertising in 1953. Before joining Gas Lift he worked for Standard of Louisiana, United Gas and Moody-Seagraves.

•

McCullough Tool Company has announced the appointment of **Harry E. Hester** as executive assistant to the president, **I. J. McCullough.** Hester will aid the president in all phases of company operations. Hester joined McCullough Tool Company in 1941 as sales engineer, later served as purchasing agent and since 1944 as export and personnel manager, Pacific and Mountain divisions. For seven years prior to joining McCullough, Hester was associated with Grant Oil Tool Company and previous to that was with Medearis Oilwell Supply.

•

A. M. Byers Company, Pittsburgh, has announced the appointment of **Ramon I. Lindberg** as director of corrosion research. Lindberg will head up a full-scale research program aimed at developing the potentials and increasing the applications of wrought iron. He has been associated with Sinclair Research Laboratories, Inc. (a subsidiary of Sinclair Oil Corporation) in Harvey, Ill., for the past 10 years. His duties at Sinclair have included positions as acting director of the corrosion division and patent coordinator. He has also been connected with General American Transportation Corporation, East Chicago, Ind., and Jos. E. Seagram & Sons, Inc., Louisville, Ky., in various research engineering capacities.

•

Everett P. Carley, chief engineer for the **George E. Failing Company** is on an extended trip through Europe and Asia. Carley's itinerary calls for visits to users of Failing rigs in Holland, Saudi Arabia, Turkey, France, Germany, Belgium and England.

•

Joseph North has been named U. S. representative **Oilwell Engineering Company, Ltd.,** of Stockport, England, succeeding **E. F. O'Connell,** resigned. During the past ten years North has been the company's deputy representative in New York.

•

Jack Cruce has been named division sales engineer, **Lane-Wells Company,** with headquarters in the Enterprise Building, Tulsa.

•

Jones & Laughlin Supply Division, announced the appointment of six men to the position of sales representative in the firm's field sales operations. **T. W. Small,** formerly manager of J&L's supply store at Longview, Texas, has been promoted to salesman at that location; and **Carl J. Bates, Robert F. Bunce, Albert A. Darby, Don T. Henderson** and **John L. Leimbrook** have been assigned to serve as J&L sales representatives at the following store points, respectively: Great Bend, Kansas; Williston, N. D.; Houma, La.; Shreveport, La.; and Alice, Texas. Small joined the oil field supply firm in 1940, as a storeman at Kilgore, Texas. In 1945 he was appointed local store manager at Oil City, Miss. He remained at that location until his transfer to Longview in 1951.

•

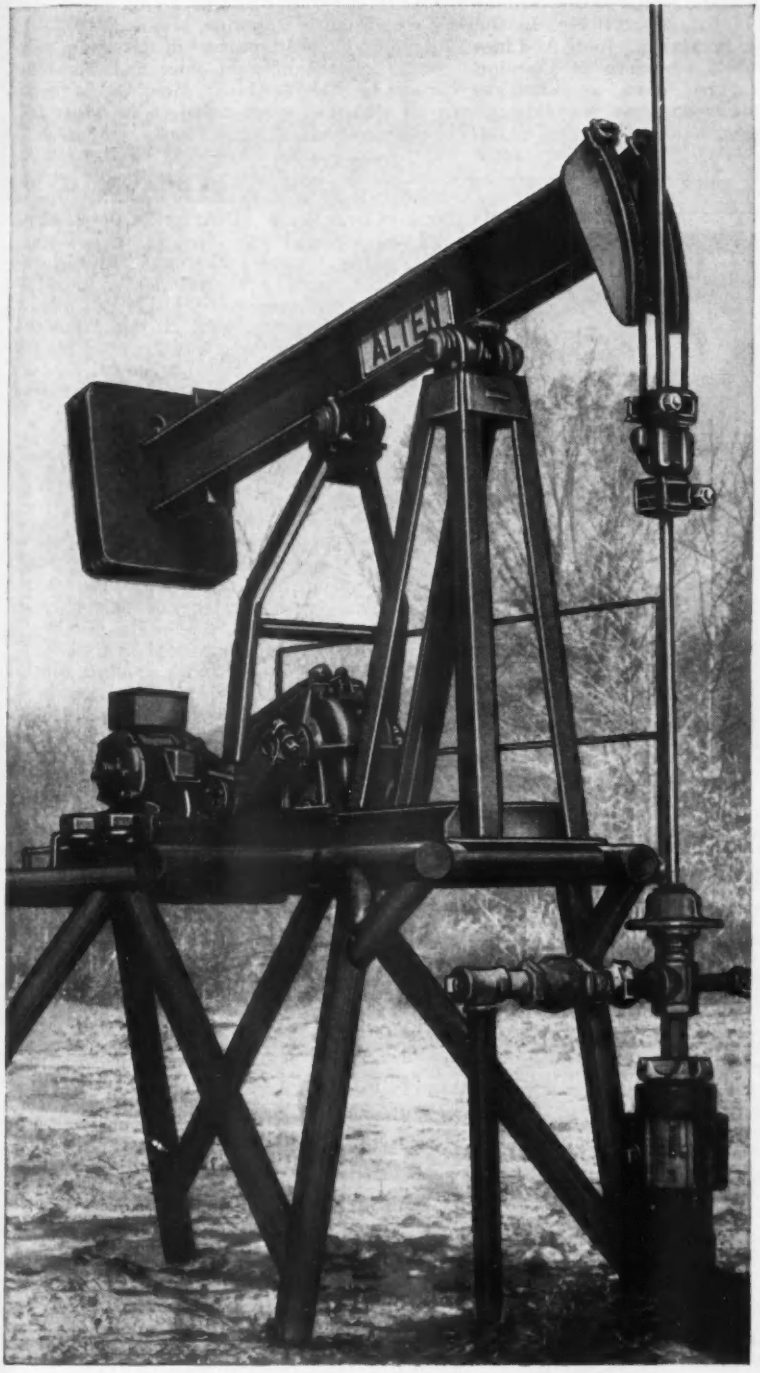
Richard K. Teske has been appointed as sales representative for **Leschen Wire Rope Division, H. K. Porter Company, Inc.** His territory will cover Michigan and northern Indiana. He has been working for the past 10 years in and around the gravel industries of southeastern Michigan, acquiring ample experience with wire rope.

•

Cherokee Laboratories, Incorporated, of Tulsa announced the appointment of **C. D. (Dave) Clarke** as sales representative for West Texas and New Mexico. Clarke was formerly a mud engineer with The Baroid Division, National Lead Company, in Beaumont, Texas. Prior to that, Clarke was employed by The Houston Oil Field

NEW it's from ALTEN

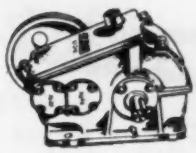
Rugged - Dependable - Years Ahead



the NEW ALTEN A-3F-D6 "Mustang"

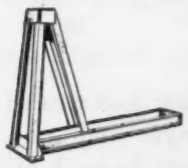
Small but powerful, like the hardy Mustang of the prairies, the Alten D-6 "Mustang" is an all new unit designed especially for low-cost, long-term operation of waterflood projects and shallow wells. The "Mustang" is another indication of Alten leadership in pumping unit design. Ever since the first pumping units were built for early Pennsylvania fields, the Alten line has been continually improved and expanded. This great new unit is the recent result of Alten experience and advanced engineering technique.

NEW REDUCER



Completely new, engineered exclusively for this miles-ahead D-6 unit. Lower tooth pressures and longer life are provided by the extra width gear faces. New low-level oiling system is made positive by Alten's unique oil wipers. Double-ribbed reducer housing . . . oversized tapered roller bearings.

NEW FRAME



Frame and samson post assembly are all new, the most rugged frame on any small unit. Four legged heavy samson post designed to handle maximum loads with ease.

NEW EQUALIZER

The equalizer and pitman assembly is amazingly sturdy and trouble-free. It incorporates several time-tested principles normally found only on larger units.

ALTEN PUMPING UNITS . . .

Available from the Supply Store of your choice.

Write for complete information.

ALTEN *Since 1889*

FOUNDRY & MACHINE WORKS, INC.
LANCASTER, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

Material Company and William Cameron Lumber Company.

•

S & R Tool & Supply Co., Houston, has announced appointment of **Wayne Sprecher** as chief engineer. He came to S & R from Texas Iron Works where he had been equipment design engineer and chief of mechanical drilling equipment division.

•

Chris G. Knoerzer, a vice president of the **Republic National Bank of Dallas** since 1947, has been elected a member of the Bank's Executive committee. He joined the staff of Republic in 1925, becoming manager of the Bank's Credit department in 1939. In subsequent promotions, he became an assistant cashier in 1941 and an assistant vice president in 1946. Elected a vice president in March of 1947, he has been active in Republic's Commercial Loan department in recent years.

•

Jones & Laughlin Supply Division, headquartered in Tulsa made these changes. J&L sales representatives **Cecil J. Kriewitz, Lester L. Reed** and **Eldon J. Pierson** have been assigned to Denver; Glendive, Mont.; and Perryton, Texas, respectively. In the firm's Canadian operations, **John A. Lineham**, formerly a storeman at Drayton Valley, Alberta, has been promoted to sales representative to serve the Edmonton, Alberta, area. Kriewitz joined J&L in 1951 as a storeman at Casper, Wyo. Reed started as a storeman at the firm's Winfield, Kansas, store in 1951. Pierson became associated with J&L in 1952. Lineham entered the firm's employ as a storeman at Edmonton, Alberta, in 1954, and in March, 1955, was transferred to Drayton Valley where he served as a storeman until his recent promotion.

•

Arthur I. Coyle has joined the Drilling Mud Sales staff of **Minerals & Chemicals Corporation of America**, Menlo Park, N. J. Coyle will headquarter in Houston and be in charge of field sales and development of Minerals & Chemicals' products. He will work on new products for both salt water and fresh water drilling muds in addition to Minerals & Chemicals' long established salt water muds. Coyle brings to Minerals & Chemicals Corporation of America more than 25 years of oil and chemical experience. He was on the editorial staff of Offshore magazine, serving as technical editor for the past year and until his recent move. He has had eight years' chemical experience with American Cyanamid Company and two years' with the Rumford Chemical Works. While with Cyanamid, he was technical salesman on industrial chemicals and mud engineer in charge of field development work on new products for drilling muds in the Mid-Continent and Gulf Coast areas. He was technical director of the Petroleum Chemicals division of Rumford Chemical Works, with his efforts directed to the petroleum industry and related chemical products. Coyle's early work experience was in the oil fields of Texas and Louisiana. He started out as a roughneck, rigbuilder, driller and progressed to tool pusher and drilling superintendent and, finally, to drilling contractor.

Arthur I. Coyle

James B. Hartzog

James B. Hartzog has been appointed manager of sales and service for **S & R Tool and Supply Co.** Hartzog formerly was with Ideco Division of Dresser Industries, where he served for a number of years as manager of the Specification and Price department, later was appointed special assistant to the sales manager and subsequently became manager of the Full View Mast department. In all, he has had 12 years' experience in the oil field drilling equipment business.

•

G. L. Pitzer has been appointed vice president—production, of **Bakelite Company**, a division of Union Carbide and Carbon Corporation. Pitzer started with Union Carbide in 1933 in the South Charleston, W. Va., laboratory of Carbide and Carbon Chemical Company. He has held various positions in the Union Carbide organization including that of superintendent of

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NO WELDS TO BREAK . . .

Each SPANG WELDLESS JAR is forged from a single piece of selected alloy steel and is scientifically heat-treated and tempered to obtain proper hardness and toughness in the rein sections for maximum strength and wear resistance in the most severe drilling service.

The joints, heat-treated and precision machined, are stronger and more durable, assuring fewer fishing jobs. Records over the years show up to four times more footage with SPANG Alloy-Steel WELDLESS JARS.

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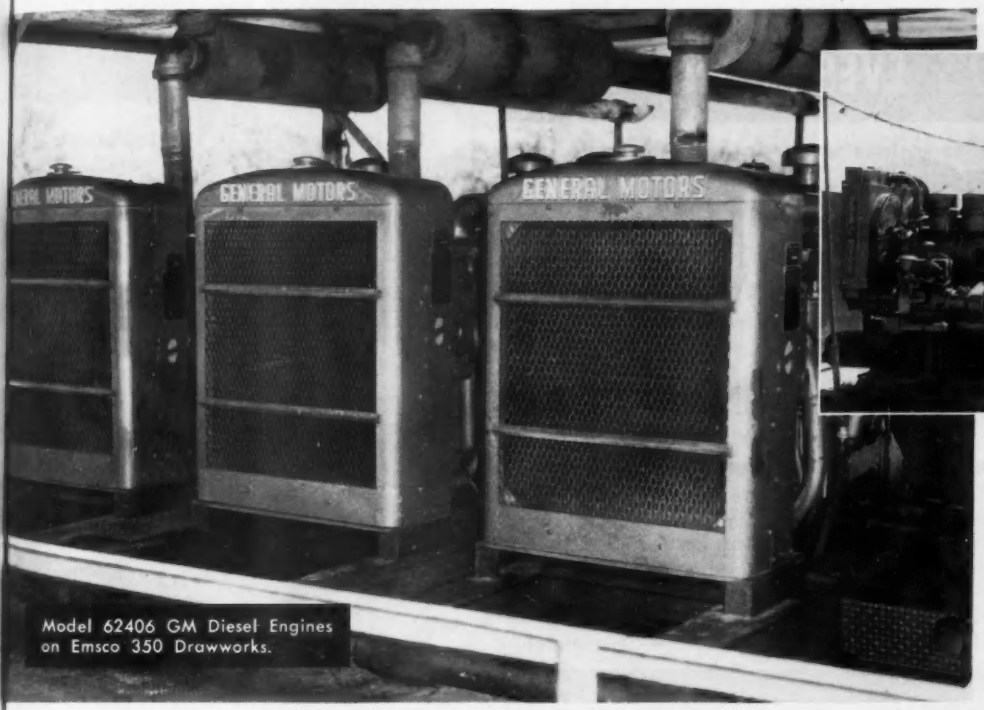
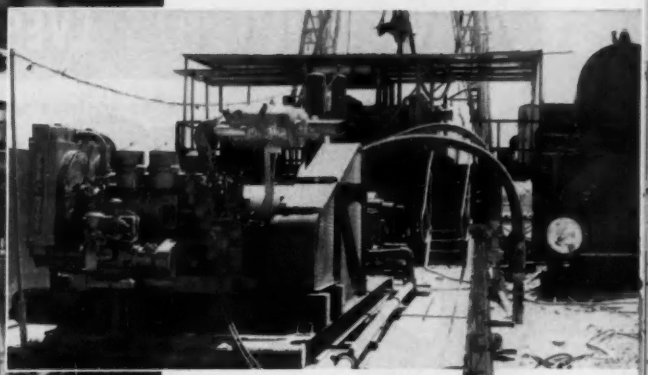
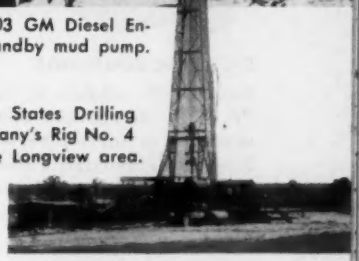
For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

DEPENDABLE POWER



Model 62406 GM Diesel Engines on Emsco 350 Drawworks.


Model 12103 GM Diesel Engine on Standby mud pump.


South States Drilling Company's Rig No. 4 in the Longview area.

STORY OF A "REVITALIZED" RIG

When South States Drilling Company, Longview, Texas, decided to repower their Rig No. 4, they chose Stewart & Stevenson GM Diesel Power through Industrial Power & Supply. Gas/butane powered engines formerly were used.

The results?

"We noticed a decided improvement in power and acceleration," Mr. B. J. Baird testifies, "particularly in coming off bottom with a heavy string of drill pipe. We were able to reduce our trip time considerably."

Rig No. 4 has an Emsco GA 350 Drawworks with a 7¼-inch by 14-inch Gardner-Denver mud pump. This was repowered with three 6-110 GM Diesel Engines. Also, Rig No. 4 has a B-14 Emsco mud pump for stand-by service powered by a Model 12103 GM Diesel Engine.

This drilling contractor found the pump on the compound could be used to its rated capacity after the repowering job. This is without loss of drilling power on the rotary table.

Economy: "A 40% savings over our past operation," Mr. Baird says.

Overall performance: "Well pleased."

Service: "Excellent."

Stewart & Stevenson Services, Inc., the world's largest distributor of diesel engines, has the answer to your drilling power needs, regardless of the size or type of your rig.

A combination of the right power and utmost efficiency in service means more efficient operations for you. And that's money in the bank.

STEWART & STEVENSON

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We're proud of our record in meeting every power need for the nation's leading drilling contractors

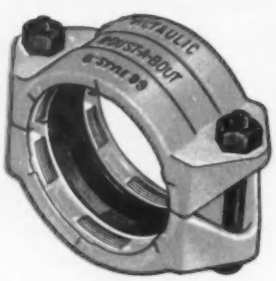
THE WORLD'S LARGEST DISTRIBUTOR OF DIESEL ENGINES

VICTAULIC®

METHOD OF PIPING

VICTAULIC HAS EVERYTHING...

VICTAULIC COUPLINGS
Simple, fast, reliable. *Styles 77, 77-D,* for standard uses with steel or spiral pipe, — *Style 75* for light duty. Other styles for cast iron, plastic and other pipes. Sizes ¾" to 60".

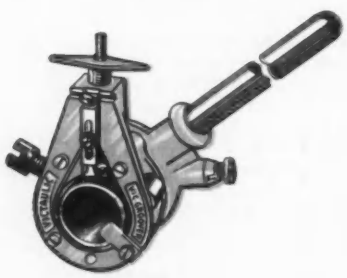


ROUST-A-BOUT COUPLINGS
For plain or beveled end pipe *Style 99.* Simple, quick, and strong. Best engineered and most useful plain end coupling made — takes a real "bull-dog" grip on the pipe. Sizes 2" to 12".

VICTAULIC SNAP-JOINTS
The new, boltless, speed coupling, *Style 78.* Hinged into one assembly for fast piping hook-up or disassembly. Hand locks for savings in time and money. Ideal for portable lines. Sizes 1" to 8".

COUPLINGS FOR EVERY PIPING JOB

VICTAULIC FULL-FLOW FITTINGS
Elbows, Tees, Reducers, Laterals, *a complete line*—fit all Victaulic Couplings. Easily installed — top efficiency. Sizes ¾" to 12".



VIC-GROOVER TOOLS
Time saving, on-the-job grooving tools. Light weight, easy to handle — operate manually or from any power drive. Sizes ¾" to 8".

PLUS FITTINGS AND GROOVING TOOLS

"EASIEST WAY TO MAKE ENDS MEET"

Promptly available from distributor stocks coast to coast.
Write for NEW Victaulic Catalog-Manual No. 57-G-6

VICTAULIC COMPANY OF AMERICA
P. O. BOX 509 • Elizabeth, N. J.

the Canadian Resins and Chemicals Limited plant at Shawinigan Falls, P. Q., Canada, and assistant superintendent, Texas City plant, of Carbide and Carbon Chemicals Company. He moved to New York in 1952 to fill the post of works manager for Bakelite Company.

•

Doss Hamilton

Bill Louderback

H. E. Crocker

Tom McClelland

L. Gene Posey

Harry A. Riley, Jr.

Weatherford Oil Tool Co., has made three additions to its staff and two promotions in Houston. **Bill Louderback** has been employed as assistant public relations, advertising and training manager with headquarters in Houston. He most recently was associated with Permian Mud Service in Odessa, Texas. Recently employed as sales and service engineer for the Abilene, Texas, district was **L. Gene Posey.** He had worked for several years in the oil fields on drilling crews. **Tom McClelland** is the new sales and service engineer for the Lafayette, La., district. Until joining Weatherford, he was a field salesman for the Continental Supply Co. in Houma, La. **H. E. Crocker** has been promoted to district manager in the Northern division with offices in Casper, Wyo. Crocker has worked as a driller in Texas and Alaska. The new assistant Northern division manager in Oklahoma City is **Doss Hamilton,** former sales and service engineer in Odessa.

•

Harry A. Riley, Jr., has joined the staff at **Southwestern Plastic Pipe Company.** Riley will represent Southwestern as a field representative in sales development

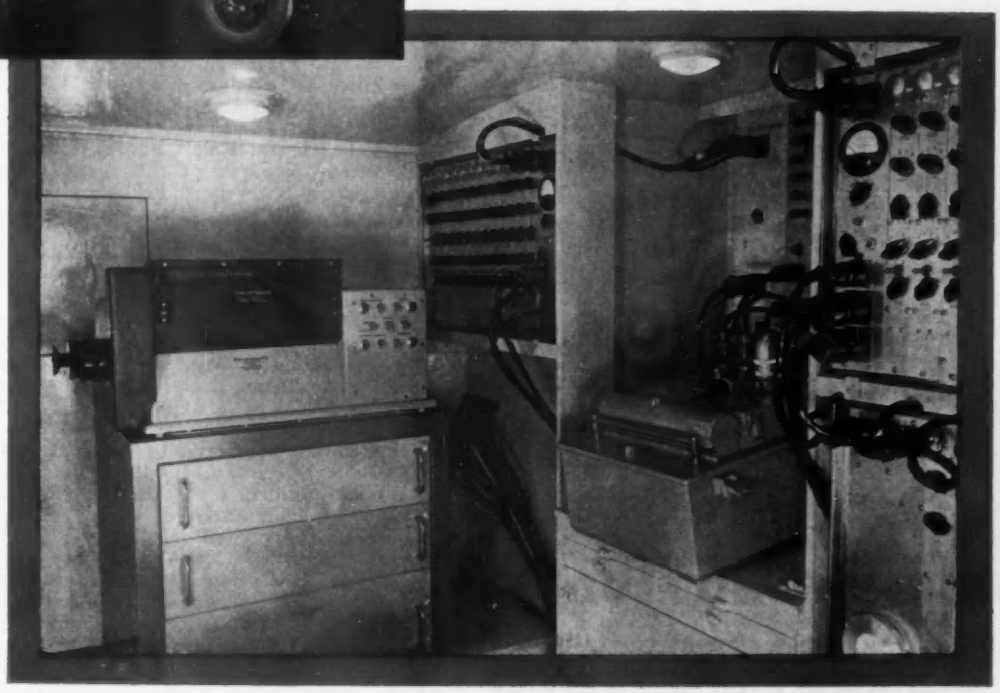
Recognizing that delays in interpretation can sometimes be costly, Petty offers a time saving answer with the "Mobile Vari-Plotter," an on-the-scene data processing laboratory contained in the field recording truck. This magnetic recording unit is capable of quickly producing fully corrected record sections at the site of Petty exploration parties anywhere in the world.

For Today's Exploration

THE FASTEST THING ON WHEELS

Right inside this recording truck, corrections for weathering, elevation and step-out are all applied, and records are timed to a common datum reference in just a matter of hours. Because the "Mobile Vari-Plotter" eliminates the need for central office record processing, your exploration dollar goes farther when using this new Petty service.

Again, Petty's personnel, equipment, methods and experience have teamed up to give you more advanced, economical and rapid exploration service. Put it to profitable use . . . today. Phone, write or call the nearest Petty office.



"Mobile Vari-Plotter" truck carries magnetic recording and complete data processing equipment

Petty

GEOPHYSICAL ENGINEERING CO.

SAN ANTONIO 5, TEXAS

District Offices: Houston, Tulsa, Billings, Lafayette

SEISMIC GRAVITY MAGNETIC SURVEYS

work with major emphasis on Southwestern's new Chem-Weld drain pipe. This new product is reported to be a completely new type of pipe in the drain field. He will also assist in the development of markets for Southwestern's Polyethylene and Kralastic pipe.

•

Samuel E. Clark, Jr., was appointed manager of the Corpus Christi, Texas store of **United States Steel Corporation's** Oil Well Supply division. Clark was employed by Oilwell in 1950 at Victoria, Texas. In 1951 he was transferred to Alice, Texas, where he was appointed store manager in the following year. He left the employ of Oilwell in 1954, returning in 1956 as district representative at Corpus Christi, the position he held prior to his present appointment.

Albert J. Rosado

R. G. Taylor, Jr.

Cleaver-Brooks Company announced the appointment of **Albert J. Rosado** as export manager of Cleaver-Brooks and Cleaver-Brooks Western Hemisphere, Limited. As export manager he will be directly in charge of all foreign operations in the sale of the company's steam generators, road machinery, burners and distillation equipment. Rosado was associated with the Norcor Manufacturing Company covering their export work in Europe, Arabia, South Africa, Latin America and the Middle East.

•

Byron Jackson Division announces the appointment of **Ray G. Taylor, Jr.**, to the newly-created post of manager of engineering in the recently consolidated Oil Field Products Engineering department. **Ted Jurling** continues as chief engineer for tools and **John Grant** remains chief engineer for rubber products, both under Taylor's direction. In addition to heading the consolidated engineering activities, Taylor will supervise Byron Jackson field engineers and will draw upon the resources of the Borg-Warner Central Research Laboratory for collateral assistance in the over-all program.

•

Daniel H. Reat has accepted a position as assistant to the advertising manager of **Reed Roller Bit Company.** Reat joined Reed February 11. He had previously served four years as advertising manager of Bowen-Itco Co. He has also done commercial art work.

•

Schlumberger Well Surveying Corporation has appointed six new district managers and an assistant area manager. The following have been named district managers: **J. T. Douglas** at Morgan City, La.; **W. H. Player** at Natchez, Miss.; **P. H. Hines** at Donaldsonville, La.; **W. P. Baker** at Evansville, Ind.; **R. R. Shourd** at Wichita Falls, Texas; and **J. C. Givens** at Big Lake, Texas. **Ralph Burton**, formerly assistant manager of the north Louisiana area in Shreveport, has been transferred to Houston as assistant area manager of the Southwest area.

•

William R. Hoge, president of the First National Bank of Pueblo, Colo., has been elected a vice president and member of the executive committee of the **Republic National Bank of Dallas.** Hoge, who began his duties with Republic in March, is a director of the First National Bank of Colorado Springs and of the First National Bank of Pueblo. In 1943, he became a vice president of the Liberty State Bank, which later changed its title to the National City Bank of Dallas (1946). He remained with National City until his election as president of the First National Bank of Pueblo in 1951. Meanwhile, the National City Bank was consolidated with Republic National Bank in 1954.

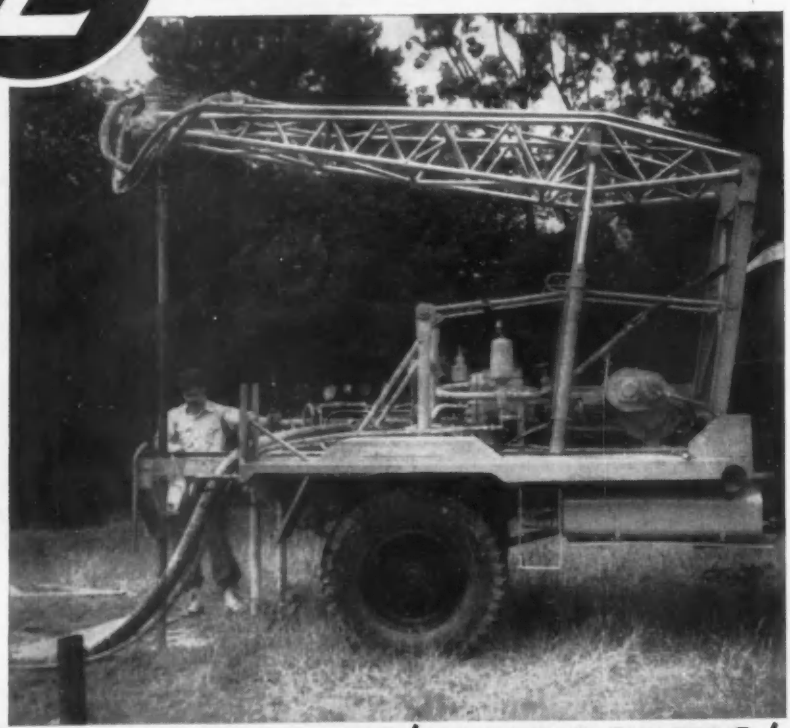
•

Eastman Oil Well Survey Company announced the appointment of **Robert M. Smith** as general sales manager of the company. Prior to joining the Eastman organization, Smith was connected with the Cardwell Manufacturing Company for many years in a like capacity.

•

Welex Jet Services, Inc., has made two new appointments in the oil well service company's Gulf Coast division. **Otto H. Menke** has been named sales engineer for the Lake Charles, La., district and **Lewis A. Cobb** has been appointed Gulf Coast division radioactivity logging engineer. Menke has more than 12 years in oil well

DRILLMASTER 300 P.A. ROTARY DRILL



QUICKER DRILLING/ NO FLOODING/

The Drillmaster Power-Arm Drill represents an advanced approach to the truck/trailer mounted prospecting drill problem. The rotation of the drill pipe and bit is by means of motors mounted in a gear box at the upper end of the drill string. The rotary head, as this gear box is called, is moved up and down with the drill string by means of an arm which is pivoted at its front end.

The arm, and thus the rotary head which is mounted at the rear of the arm, is raised and lowered by jacks mounted a short distance to the rear of the arm front pivot point. In order that the rotary head shall travel up and down on a vertical straight line, a system of links is attached towards the front end of the arm, and to the front frame (about the top end of which the front end of the arm pivots); these links move the front pivot point of the arm forwards and rearwards thus maintaining the position of the rotary head above a fixed point. The system of links is a modified form of the well known "Scott-Russell" straight line motion and causes the rotary head to travel on a vertical straight line over the length of movement permitted by the jacks.

A guide mounted vertically under the rotary head, and a short distance above the ground, holds the first length of drill pipe, and the bit, vertically and prevents the turning bit from wandering at the commencement of the hole. As drilling progresses the guide serves to reduce whip in the drill string and so assists in maintaining the drilling of a straight hole. Send for illustrated bulletin.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD
MANUFACTURERS OF GEOPHYSICAL SUPPLIES
LETCHWORTH HERTS ENGLAND TEL: 600 CABLES: OIL LETCHWORTH ENGLAND

RECTOR type "M"

..the Tubing Head that's WAY ahead

..in Flexibility

MANDREL HANGERS

Type "A" Mandrel Hanger threaded for EUE or regular tubing.

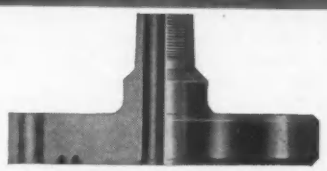
Type "M" Stripper for tubing heads with locking screws.

Type "A-O" Mandrel Hanger threaded, also grooved for locking screws. The "O" Ring serves as temporary seal.

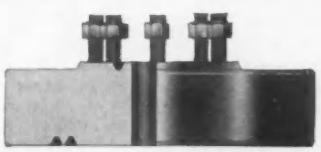
Type "WM" Wrap-Around Mandrel. It is hinged to wrap around tubing; also grooved for locking screws.

Type "C" "Slick Joint" Mandrel grooved for locking screws. The "O" Ring serves as temporary seal.

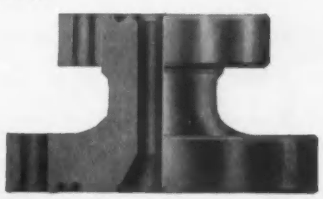
BONNETS



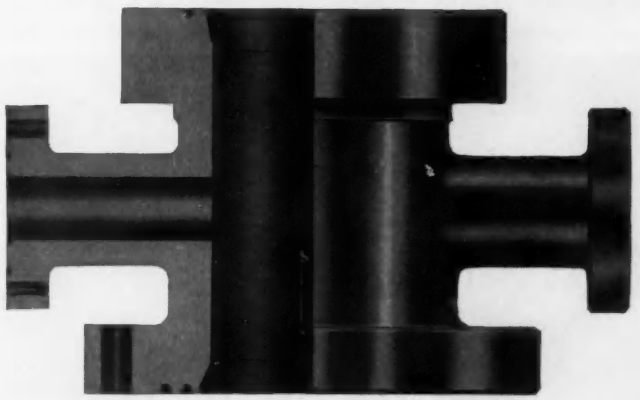
Male threaded bonnet also available with underside female threaded to hang tubing.



Studded bonnet also available with underside female threaded to hang tubing.



Spool-type bonnet also available with underside female threaded to hang tubing.



The wide range of body types (6), the complete range of pressures (2,000 to 15,000 lb. test), the variety of mandrel hangers and bonnets (10) . . . all of which are interchangeable in the bodies, plus auxiliary equipment, make it possible to select a Rector Type "M" Tubing Head for every well completion condition and preference.

Every one of these heads employs the proven Rector principle of sealing with steel . . . a single API Ring Gasket acting dually as seal and hanger hold-down. There are no soft or resilient seals in these heads to deterioriate, burn out, freeze or contract in extremely low temperatures.

When planning well completions . . . specifying Christmas Trees . . . specify a Rector Type "M" Tubing Head for the utmost in safety and flexibility.

For complete specifications of all Type "M" Tubing Heads, Mandrels and Bonnets, see the Composite Catalog.

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER

1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

service work; the past year has been with Welex in various field jobs. Cobb joined Welex four years ago as a trainee. He worked as a radioactivity logging operator before becoming the division R/A engineer.

•

Robert L. Picou, sales engineer for **McCullough Tool Company** at Houma, La., has been transferred to Harvey, La., where he will serve as branch manager. Picou has had over six years experience as an operating engineer and was in the Geophysical department of Shell Oil Company for nine years before joining McCullough.

•

Axelson Manufacturing Company, division of U. S. Industries, Inc., recently announced the appointment of O. G. Goodwin as sales representative for the Rocky Mountain area. Goodwin will be located in Casper, Wyo. He first joined Pittsburgh Plate Glass Company and is a gratuate of their Mellon sales school and remained for ten years in their employe before joining Axelson. **George Browning** and **C. D. Dacus** have joined the Hydraulic Service section of Axelson. Browning was assigned the Northern Texas area, with headquarters in Wichita Falls and Dacus the Oklahoma area with headquarters in Oklahoma City.

•

Robert M. Sherrard was appointed area manager, production equipment sales, for **United States Steel Corporation's** Oil Well Supply division at Casper, Wyo. Sherrard was employed in 1936 by Oilwell at Casper and worked for the division at Salem and Clay City, Ill. Later he was store manager at Mattoon, Ill. Later in the same year he was transferred to Olney, Ill., as district material supervisor, becoming district merchandise manager at this location in 1951. In 1954 he was appointed district representative at Casper, the position he held prior to his present appointment.

•

G. B. Blair

R. O. Moore

W. A. Sellers

J. P. Jones

Mid-Continent Supply Company recently announced the promotion and transfer of four men in the company's Fort Worth, Texas, headquarters. New general manager of buildings and construction is **R. O. Moore,** former general mechandise manager. Moore is a veteran of 23 years of service with Mid-Continent and has been in the Fort Worth headquarters since 1937. Assuming new duties as general merchandise manager was **W. A. Sellers,** formerly assistant to general division manager. Sellers, who has been with Mid-Continent since 1948, moved in Fort Worth headquarters in 1956 from the company's West Texas-New Mexico division. New assistant to general division manager is **J. P. Jones,** former assistant to general manager of sales. Jones has been with Mid-Continent 15 years and served in the company's Gulf Coast division before moving to Fort Worth last year. Assuming a new position in the Fort Worth offices as assistant to general manager of sales was **G. B. Blair,** former Shreveport district manager. Blair, who has been at Shreveport since 1951, has been with Mid-Continent since 1937.

•

The Western Company, oil well servicing concern with headquarters in Midland, Texas, has announced five personnel changes in its Rankin, Texas, district office. **Earl Pfaff,** former station supervisor in Rankin, now is the district manager. He started working with Western in 1952 as a driver in Odessa, and later served as service engineer and field supervisor in Seagraves, Texas, before being transferred to Rankin in 1955. Now serving as station supervisor is **Grady Holder,** former treating engineer in Seagraves,

Don't let vapor losses (or other thieves) steal you blind.

1. Corrosion of tanks. Reduced when correct pressure setting is maintained on all tanks in storage battery, and oxygen is excluded.
2. Gravity drop (premium of 2c per barrel) can be stopped. Many users of vapor control system have reported gravity increases after installation.
3. Volume losses (2½% per degree gravity drop). Very substantial savings have been reported.
4. Lifting costs. These costs can be cut, because with the gravity and volume losses stopped, every barrel produced is saleable.

The elimination of any one of these thieves will more than pay for the installation of an Enardo vapor control system.

The Enardo 770 "By-Pass" thief hatch valve shuts off from the vent line for vapor control. When the hatch is open the "By-Pass" controls the opening into the vent line, sealing off the rest of the tanks in the battery. This automatically holds the correct pressure settings and excludes oxygen. Holding the pressure in all tanks prevents large gravity and volume losses during normal working conditions. The 770 Series hatches feature "bottle-tight" seals and De-icer action gaskets.

Call, write or wire Enardo for additional information.

770 VAPO-GARD THIEF HATCH VALVE

770-BP VAPO-GARD THIEF HATCH VALVE

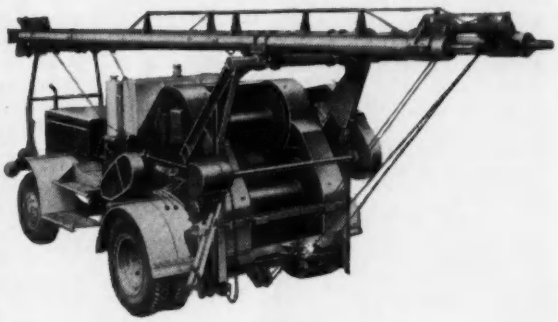
ENARDO manufacturing company

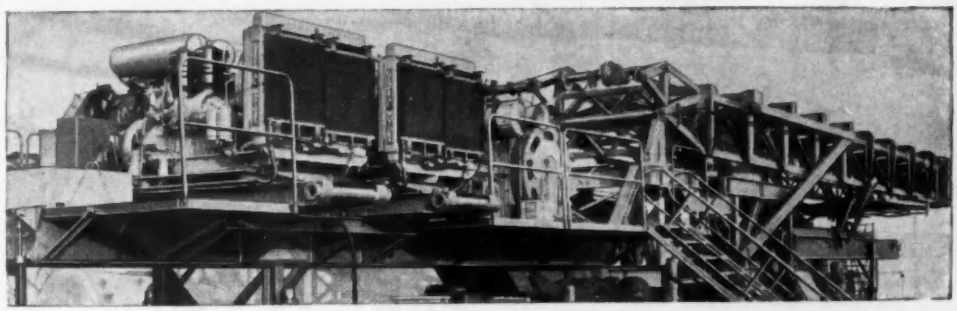
BOX 1647 TULSA, OKLA

WOODFIELD OF ROCHESTER

Woodfield are licensees in the United Kingdom for the manufacture and sale of the range of I.D.E.C.O. drilling and production equipment.

The Woodfield plant at Rochester, constantly developing and enlarging its facilities, provides the means of producing first-class equipment. This, combined with frequent visits of senior technical and service personnel to fields and installations the world over, provides a service indispensable to operators requiring special equipment.



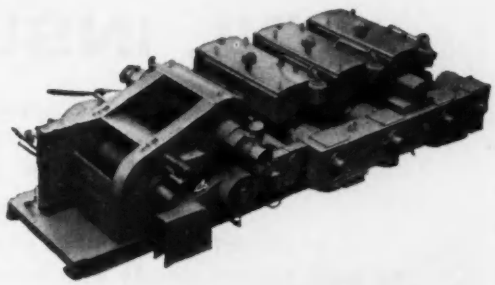


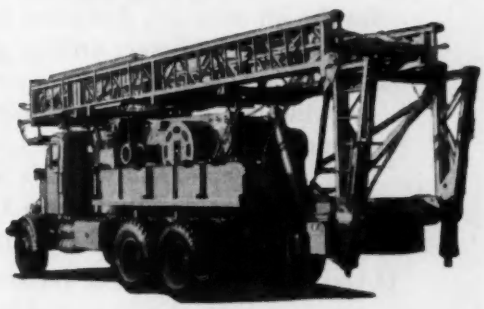
Top illustration:
Woodfield "Fieldmaster" Mobile Well Servicing and Workover Rig. Well depths up to 4,000 ft.

Centre illustration:
WOODFIELD built IDECO Hydrair H525 Dual Rambler drilling and servicing rig for wells 7,000/8,000 ft. depth. Drilling to 7,500 ft. with 4½" drill pipe.

Right illustration:
WOODFIELD built IDECO Hydrair H.40-D Double drum draw-works with 3 AEC engines, 450 H.P. and 4 shaft drive compound.

Lower right illustration:
WOODFIELD built IDECO H20 double drum Well Servicing Rig. Well depth 3,000-4,000 ft.





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Texas, and Cushing, Healdton and Lindsay, Okla. He also started his career with Western as a driver in Odessa. **Wallace Arnold**, former field supervisor in Snyder, Texas, now has the same job in Rankin. He has been with Western since 1953, when he started work as a trainee in pumping services at Ulysses, Kansas. **William H. Seabolt** has been transferred from Rankin to Midland as senior sales engineer in the Sales division. He started work as a driver in Eunice, N. M., in 1952. Seabolt was district manager in Rankin before his transfer. **J. T. Weaver** is the new area sales supervisor in the Rankin district. He started work in Snyder as a driver, and has been a pump operator, treating engineer and salesman.

•

Emmett H. Mann has been named vice president and general manager, **Leschen Wire Rope Division, H. K. Porter Company, Inc.** Until his present appointment he held a similar post with the Alloy Metal Wire Division. Mann joined Alloy seven years ago as a sales engineer, became its sales manager and in 1956 its general manager.

•

Douglas W. Vernon has been named product sales manager for wire rope and aircord by **John A. Roebling's Sons Corporation.** Vernon was formerly vice president and general manager of the Leschen Wire Rope Division of the Watson Stillman Company. His office is located at Roebling's main plant, Trenton, N. J. Prior to joining the Leschen organization in 1945, Vernon had been employed by Roebling for more than 23 years. He entered the corporation's Chicago district office in 1922 and was named assistant district manager in 1939. Transferred to Trenton in 1942, he worked in the Purchasing department and a year later was made assistant to the general manager of sales.

•

Walter J. Verlander

R. R. Aulick

Power Specialty Company announced the appointment of **Walter J. Verlander** as manager of its newly established New Orleans office. Verlander was recently associated with A. M. Lockett & Company, Ltd., of New Orleans where he had many years of experience in the application and sale of power plant, petroleum and petro-chemical equipment.

•

Hughes Tool Company has appointed **R. R. Aulick** as regional engineer with headquarters in Oklahoma City. Aulick who has been with Hughes since 1947, was previously division engineer for Oklahoma-Kansas and acting regional engineer.

•

Ted C. Lemcke and **John G. Orton** have been named special sales representatives for **Reed Roller Bit Company.** Lemcke has been with Reed since 1939 and has held the positions of serviceman, salesman, district salesman, sales training supervisor and special salesman. His service has been in Reed's Pacific Coast and Export divisions. With Reed since 1951, Orton has spent all of that time in northern South America. He is currently stationed in Barcelona, Venezuela. Prior to his new appointment, Orton was special salesman for Reed.

•

Howard J. Mullin has been appointed assistant vice president—sales—distribution of **United States Steel Corporation,** succeeding **M. M. Chapman.** At the same time, it was announced that **J. M. Curto** will succeed Mullin as manager of sales of the New York district sales office of the corporation. Mullin was first employed by U. S. Steel the same years as a sales student at Gary Works. He was made a sales correspondent in the bar bureau in 1929 and a clerk in the Chicago district in 1933, becoming a salesman a year later. In 1938 he was transferred to Milwaukee as a salesman. From 1938 to 1941 Mullin was assistant to manager of sales in the St. Louis and Kansas City sales offices. He went to Detroit in the same capacity in 1941 and was made assistant manager of sales in St. Louis in 1946, becoming sales manager at that office the same year. In 1955 he became manager of sales of the New York district sales office. On March 1 of this year he completed five months service as executive director of "The President's Citizens Advisers on the Mutual Security Program." Curto's first service with U. S. Steel was in 1937 as a sales trainee. Following this he was assigned to the Philadelphia district sales office as a

OIL INSURANCE

Drilling for oil or gas under the sea is just another venture for oil men—with certain additional operating complications, of course; but basically its problems are those of drilling for oil or gas.

Ever since the beginnings of oil operations in the Gulf, we have worked closely with insurance agents and brokers for the oil industry, designing special forms of insurance to properly protect drilling and production equipment at sea. We have arranged a pool of underwriters who can provide the protection required by new-type structures. Our offshore loss men are experienced in dealing with oil people, and we have a specialized offshore loss prevention facility to help keep insurance costs down and eliminate equipment down-time.

If your insurance agent or broker has placed your offshore insurance with us you can be assured it is in experienced and specialized hands.

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NEW ORLEANS

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FRED L. KRIEDT, LEE M. STENTZ, Vice Presidents

WHO STARTED GRAVEL PACKING ANYWAY ?

WHO PERFECTED GRAVEL PACKING WITH CIRCULATION ?

WHEN OTHER METHODS FAIL TO CONTROL THE SAND IN A WELL.... WHO SHOULD YOU CALL ?

LAYNE

Yes

THE LAYNE

GRAVEL PACK

combines the "Know How" of long experience and the proper equipment: (1) especially designed high pressure mixing drums, (2) pump manifolds, (3) control valves, (4) the correct size gravel.

This equipment is assembled and mounted on a truck. For off-shore jobs the unit is mounted on skids.

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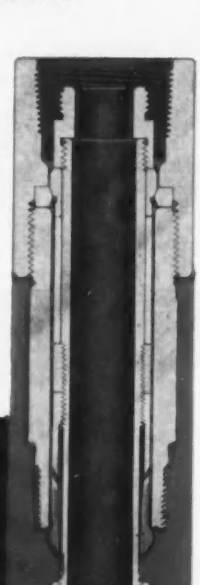
For more data on advertised products, use Readers' Service Cards, last page.

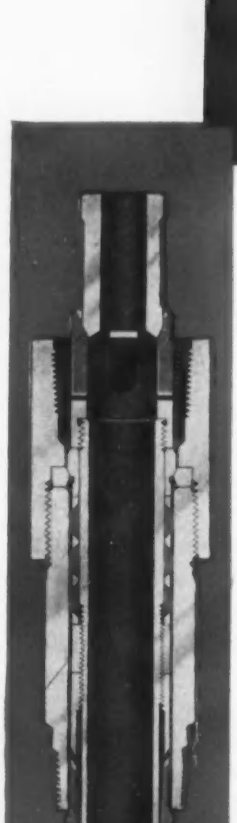
Wireline servicing made easy with a

PACIFIC
PERMANENT COMPLETION
PUMP HOLD DOWN

The Pacific Permanent Completion Hold-Down is designed with maximum opening through the shoe to permit use of Permanent Completion Tools through it. The sealing arrangement has replaceable Stainless Steel Sealing Ring with a reversible Stainless Steel Sealing Ring Seat and can be used on any type A.P.I. rod pump.



Undersize rings can also be furnished to allow pumps to be run through a Permanent Completion "S" Nipple and seated in the pump shoe.



If at any time the Stainless Sealing Ring Seat, which is part of the Tubing Assembly, should become damaged or leak, an effective seal can be obtained without pulling tubing. The Rod Assembly is engineered and designed so that by replacing the Spacer Ring on the Hold-Down Lock Body with three Ring Type Seating Cups, the seal is transferred to the Seat Support Nipple with the Sealing Ring and Sealing Ring Seat serving as a No-Go ring and supporting the load.

PACIFIC PUMPS, INC.
HUNTINGTON PARK, CALIFORNIA
Offices in all Principal Cities
Mid-Continent Division: 1221 E. 1st St., Tulsa, Oklahoma
Pacific Pumps of Canada, Ltd., Edmonton, Alberta

PACIFIC®

DW-17

clerk and was a salesman in that office from 1939 to 1943. Leaving the corporation for service in the United States Navy in 1943, Curto returned to the Philadelphia office as a salesman in 1946. He was transferred to Pittsburgh in 1950 as assistant to manager of sales in the Pittsburgh district sales office and in 1951 was promoted to assistant manager of sales.

•

E. B. Lindsey has returned to the U. S. after more than 10 years abroad as geophysical supervisor for Seismograph Service Corp. and its foreign subsidiaries. Lindsey is in Tulsa to confer with officials at SSC, after which he will be assigned a post in this country. Lindsey went to England shortly after World War II where he participated in setting up operations for Seismograph Service Limited, and to France where he performed the same functions for Compagnie Francaise de Prospection Sismique, SSC's French subsidiary. During his tour abroad Lindsey traveled extensively in Europe, the Middle East and Africa.

•

Wilbur M. Tomlinson was appointed sales manager of the Kansas City, Mo., territory of **Universal Atlas Cement Company.** Following employment by Graham Engineering Company of Muskogee, Okla., as draftsman-surveyor and by the Oklahoma State Highway Commission at Oklahoma City as assistant engineer, he joined Universal Atlas in 1928 at Kansas City as sales representative covering the eastern Oklahoma territory. In 1953, he was promoted to assistant sales manager at Kansas City, in which capacity he served until his present advancement.

•

Percy Tinsley has been appointed special offshore representative for **Christensen Diamond Products Company.** He will assist operators in the selection of diamond coring and/or drilling equipment, and when necessary, work with operators to design special equipment for any unusual problems encountered. Tinsley has been with Christensen since 1952, and until recently, managed their office in Lafayette, La. His new offices will be in Houston.

•

Dr. John A. King was appointed director of research for **Armour and Company.** Dr. King has been engaged in industrial research in the chemical and pharmaceutical fields since 1942.

•

Pat Loper was appointed advertising manager for **Brown Oil Tool Company,** and new assignments in the Sales division have been announced. Loper has been a sales engineer with Brown for four years. Previous to that, he was associated with Otis Pressure Controls, Inc., for ten years. **Frank Smith** has replaced Loper as sales engineer for the Gulf Coast. Until recently, Smith was with the Oil Center Tool Company in West Texas. A new sales engineer operating out of the Houston headquarters is **Bernie Fitzgerald. R. C. Buchanan,** sales engineer in the Houston region, has been temporarily assigned to Canada and will represent Brown with the Import Tool Company.

•

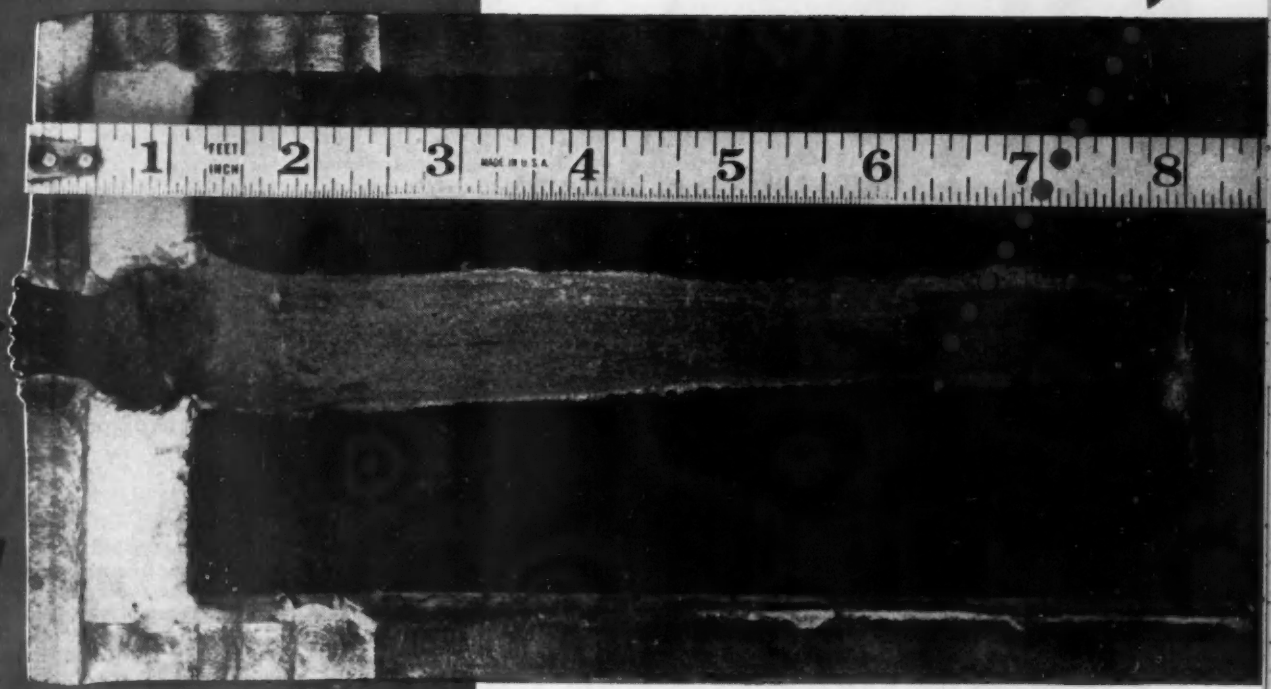
Hughes Tool Company's Western region headquarters have been moved from Midland, Texas, to the Vaughn Building, Dallas. Among those who will be located there are **E. M. Connor,** region manager;

GREATER PERFORATION DRAINAGE

PROOF . . .

In Berea Sandstone Hard Formation --NOT CEMENT

with the NEW PGAC



Berea Sandstone Core confined in 4½" drill pipe by ¾" Hydromite and ⅜" mild steel head-plate.

DYNA•JET*

*TRADEMARK of Jet Research Center, Inc., for its new jet charge developed in cooperation with Stanford Research Institute.

Performance will depend entirely on YOUR SERVICE COMPANY. So . . .

--always call PGAC

PGAC-878

Test Report . . .

While PGAC's Dyna-Jet tests in very hard Berea Sandstone (NOT cement!) did increase penetration depths, these are Dyna-Jet's more important contributions to **increased production flow** for operators . . .

Entrance Hole Areas— INCREASED 106%

Drainage Hole Areas— INCREASED 195%

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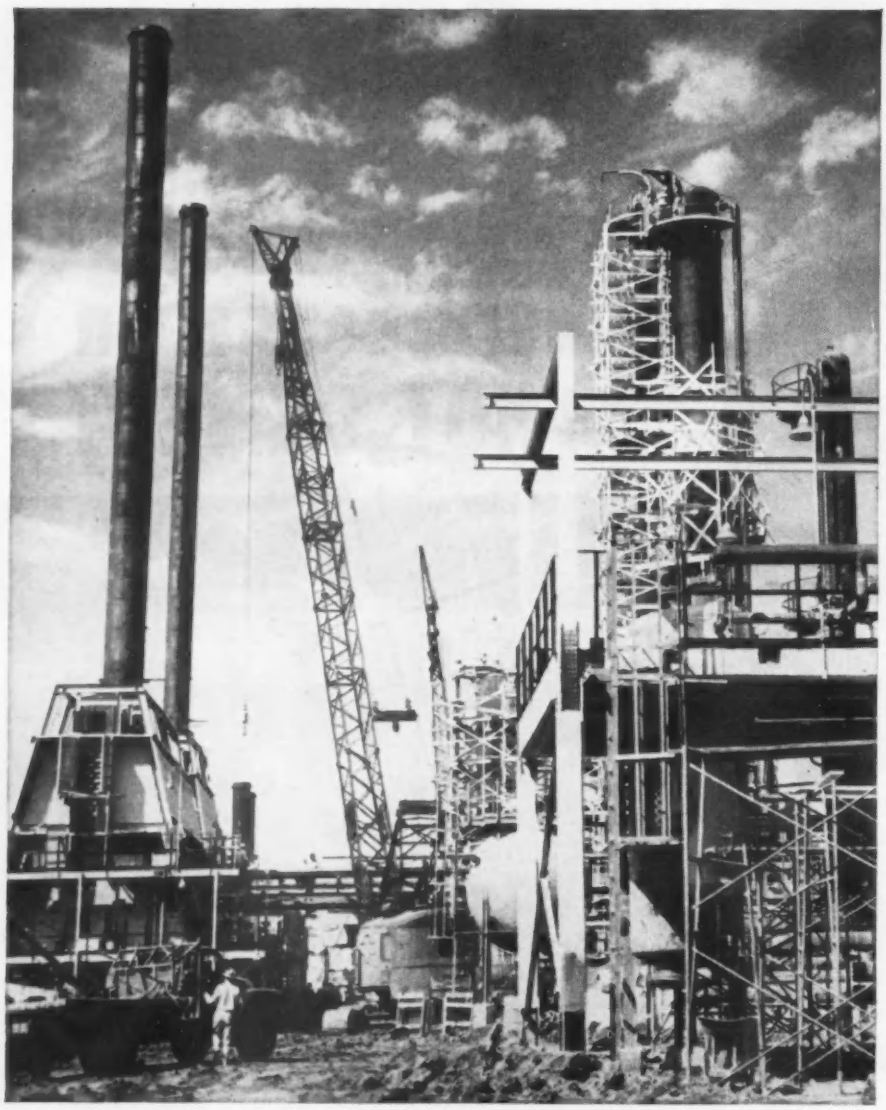
TEXAS: Abilene — Alice — Beaumont — Bowie — Colorado City — Corpus Christi — Dallas — Fort Worth — Gainesville Graham — Houston — Longview — Midland — Odessa — Pampa — Victoria — Wichita Falls.

OKLAHOMA: Ardmore — Healdton — Oklahoma City — Pauls Valley — Pawhuska — Perry — Tulsa.

LOUISIANA: Houma — Lafayette — Lake Charles. KANSAS: Great Bend — Harper — Liberal. NEW MEXICO: Hobbs.

AFFILIATE COMPANIES: CANADA — Perforating Guns of Canada, Ltd.; Edmonton, Alberta

GERMANY — Atlas Deutsch- Amerikanische Olfelddienst G. m. b. H.; Kiel VENEZUELA — Servicios Tecnicos Atlas, C.A., Caracas



CATS MULTIPLY FAST IN CANADA

Nowhere is Canada's swift industrial progress more striking than in the recent development of its oil refining and petrochemical facilities. Canada's daily refining capacity already approaches 700,000 barrels. New petrochemical plants are rising from coast to coast, to meet the demand for paints, alcohol, ammonia, plastics, detergents, synthetic rubber and other products of petroleum or natural gas.

U. S. executives interested in any branch of the oil and natural gas industry in Canada will find a useful ally, and a prompt, dependable source of information in The Canadian Bank of Commerce. Write or telegraph direct to C. H. Munro, Manager, Petroleum and Natural Gas Department, 309 Eighth Avenue, West, Calgary, Alberta, or to our Business Development Division, Head Office, Toronto 1, Canada.

(*We regret that we cannot advise on the merits of oil or mining securities*)

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Resident Representative—Chicago and more than 750 branches across Canada

H. C. Rowland, regional engineer; **Julien P. Muller,** regional special representative; **F. L. Galbreath,** regional office manager, and **Mrs. Maxine Petty,** regional secretary.

•

Earl A. Frazier has been appointed New York district sales manager for the Wire Rope and Aircord division of **John A. Roebling's Sons Corporation.** Frazier will have his headquarters in New York and will be in charge of the division's sales activities covering New York, northern New Jersey and New England. Frazier, formerly Cleveland district sales manager, has been associated with the Roebling Corporation since 1938.

Earl A. Frazier

Fred Drury

Fred Drury of **Weatherford Oil Tool Company, Limited,** Edmonton, Alberta, Canada, has been promoted from division manager to first vice president. After several years with Imperial Oil Company in Alberta, he joined Wotco, Ltd., in 1951. Weatherford has been in Canada since 1948.

•

Halliburton Oil Well Cementing Company's new manager of safety is **Harry B. Ziegler.** He succeeds **Irby B. Cate,** Halliburton veteran who retired recently. **J. I. Jordan,** formerly a safety director for field operations, has been named to the new position of assistant manager. Both Ziegler and Jordan are based at Halliburton's Duncan, Okla., headquarters. Ziegler was a driller in southern Oklahoma when he joined Halliburton in 1926 at the company's Duncan headquarters. Field assignments in Texas, Oklahoma, Louisiana, Illinois and Kansas as a tester, fieldman, credit manager and assistant division manager were held by him until 1946 when he transferred to Duncan. Since then he has helped operate Halliburton's Safety department (begun in 1945) and until his promotion was a safety director for field operations. Since Ziegler joined the department, the vehicle accident rate has been cut two-thirds. During 1956 Halliburton vehicles drove over 96,000,000 miles. As manager of safety, Ziegler directs four safety supervisors at Houston and Midland, Texas, Casper, Wyo., and Duncan, and the Duncan shops safety operations, including the shops director, first aid supervisor and assistant and industrial nurse.

Jordon joined a Halliburton predecessor company in 1934 at Ventura, Calif., and worked as driver, cementer, tester, fieldman and district supervisor until 1951 when he transferred to the Duncan Safety department from Houston. During 1956 he was on special assignment for the company's Personnel Relations department helping develop a new field training program.

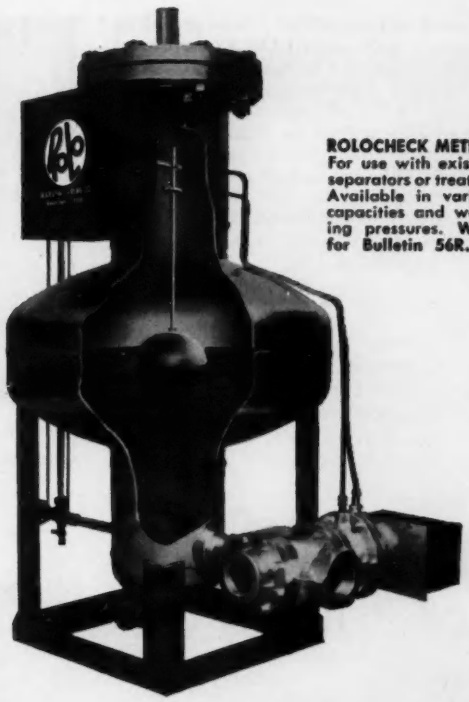
For more data on advertised products, use Readers' Service Cards, last page.

When it comes to oil field metering... there's nothing better than

ROLOCHECK

equipment

ROLOCHECK Meters measure oil by alternately filling with and discharging exactly calibrated volumes of oil. Each cycle is counted on a new, rugged counter. ROLOCHECK Meters are designed for oil field use; **proven** in oil field service... no gadgets, no unnecessarily complicated controls to fail in unattended operations.



ROLOCHECK METERS. For use with existing separators or treaters. Available in various capacities and working pressures. Write for Bulletin 56R.

Features of ROLOCHECK Meters:

(1) **Extreme accuracy.** Upper and lower liquid levels are controlled in reduced-diameter necks.

(2) **No slippage.** The new Rolo Neutral-Position 3-Way Valve is of a special design which eliminates the possibility of both inlet and outlet ports being open at once when the valve is switching ports. **Oil cannot bypass the meter.**

(3) **Minimum maintenance.** Only internals are a float and a float guide rod. Valve has sturdy rubber-to-metal inner valves. Sand and other sediments are no problem.

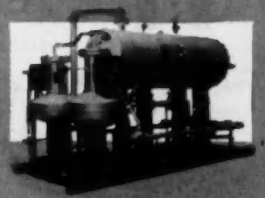
Also:

No minimum rate; will not pass free gas; new-design, rugged, foolproof counter. Equally efficient on oil or water measurement.

There's a ROLOCHECK Meter, in one of the forms shown on this page, for every application. Send in the coupon for complete information.

ROLOCHECK TWO-PHASE METERING SEPARATORS. Combine the ROLOCHECK Meter with an efficient separator, all in one vessel. Economical, space-saving. Write for Bulletin 56MS.

ROLOCHECK THREE-PHASE METERING SEPARATORS. Combine two ROLOCHECK Meters (one for oil and emulsion, one for free water) and a separator-free water knockout... all in one vessel. Write for Bulletin 56MS.



ROLO WELLCHECKERS. Completely piped separators with ROLOCHECK Meters and gas measurement facilities. Automatic free water knockouts, with ROLOCHECK Water Meters, optional. Available on skids or trailers. Write for Catalog 56W.

ROLO AUTOMATIC SAMPLER. The perfect sampling accessory to any ROLOCHECK Meter. For production containing free water, the addition of the Rolo Intermitter to the Rolo Sampler assures maximum sampling accuracy on even the highest water cuts. Write for Catalog 56W.

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Please send me the following:

Bulletin 56R ☐ Bulletin 56MS ☐ Catalog 56W ☐

NAME_____

COMPANY_____

ADDRESS_____

Fred Powell was appointed a vice president and director of **Standard Oil Company of California, Western Operations, Inc.** Powell, heretofore manager of the Western Operations, Inc. Manufacturing department, joined Standard in 1925 and previously served as manager of the company's El Segundo Refinery and as assistant manager of manufacturing. He was also formerly president of California Research and Development Corporation, a now-dissolved Standard subsidiary.

•

James H. Neelan was appointed assistant director, Advertising and Public Relations division in New York for **Universal Atlas Cement Company**, subsidiary of United States Steel Corporation. He succeeds **Edwin R. Ivy**, who resigned.

Some of the attendants at the recent management conference of Perforating Guns Atlas Corporation are seated left to right: Jake LeBus, J. H. Russell, Dr. Hans Nielsen, Paul Charrin, W. A. McKay, J. H. Castel and Cecil C. Hinson. Standing in the middle row are H. Clay Waters, E. A. White, Jack Henley, Harry Hacke, Jack Howse, J. Floyd Taylot, W. R. Rabson and Rush George. At the rear are G. Al Grissom, Cecil Clark, J. P. McHenry, Al Kangers, R. M. Haynie, John Rhodes and George Decker.

PGAC Management Conference Tells of 1956 Business Increase

Paul Charrin, president of Perforating Guns Atlas Corporation told the company's key management men attending the recent two day management conference at Houston that PGAC's business in 1956 increased 22.5 percent.

The conference was attended by Dr. Hans Nielsen, manager of PGAC's subsidiary, Atlas Deutsch-Amerikanische Oldeldienst G.m.b.H., who came from Kiel, Germany. W. A. McKay, general manager of PGAC's Canadian subsidiary, Perforating Guns of Canada, Ltd., came from Edmonton, Alberta, to attend the conference.

The managers from PGAC's district offices in Texas, Louisiana, New Mexico, Oklahoma and Kansas also attended the meetings.

Operations procedures were reviewed in detail and plans completed for the company's 1957 expansion program. Solutions were devised for problem of securing and training the many experienced technicians needed to serve the increasing demand for PGAC's logging and perforating services in this country, Germany and Venezuela.

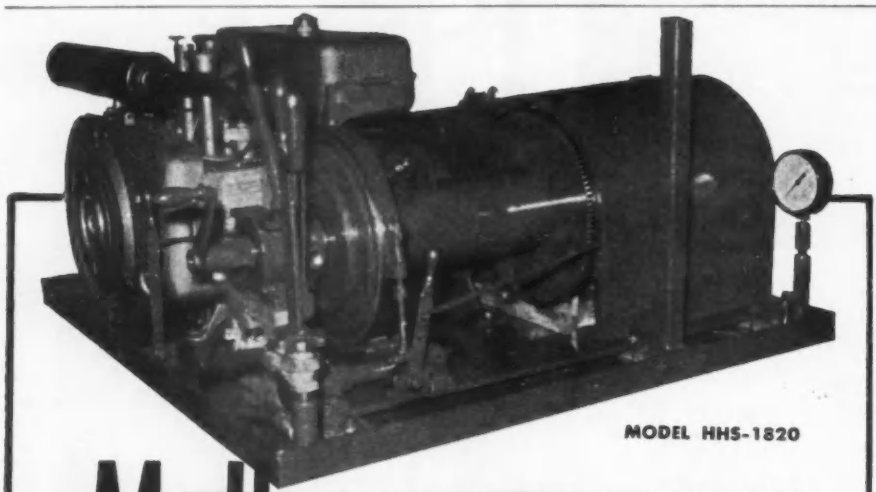
The opening last month of three new stations we announced: at Crane and Bridgeport, Texas, and at Magnolia, Ark. This brings the total number of PGAC branches to 44 stations, sales and district offices.

Charrin told the conference that PGAC's operations in Germany had been extended to two stations; in Venezuela to four branches; and in Canada to four points in Alberta Province and two in Saskatchewan Province.

Hermetic Becomes Part of SIE, One of Dresser Industries

Dresser Industries, Inc., has announced acquisition of the Hermetic Seal Transformer Co., Inc., of Garland, Texas. Hermetic manufactures electronic equipment such as transformers and reactors that are used in a wide variety of equipment for communications, radar, sonar, computers and control systems.

Hermetic Seal will become a division of Southwestern Industrial Electronics, another of the Dresser Industries. The prod-


MODEL HHS-1820

Mathey MEASURING LINE REELS

The Oil Industry's First Name in Reeling Equipment
"Never a Compromise in Quality"

Mathey Reels are available in many sizes with various drives and controls in combinations to completely meet every requirement. Choose your type of control — hydraulic or mechanical, your capacity, your line speed and pull, and your type of power—hydraulic air, electric or internal combustion engine.

Mathey's many years of experience guarantee you extra heavy duty construction, precision machining, oversize bearings and forged steel drum flanges. Mathey also engineers and manufactures specialty reels to fit your individual requirements.

USES:
- Bottom Hole Pressures
- Temperature Surveys
- Calipering
- Paraffin Cutting
- Sampling
- And Many Other Wire Line Jobs

Call or Write for Further Information

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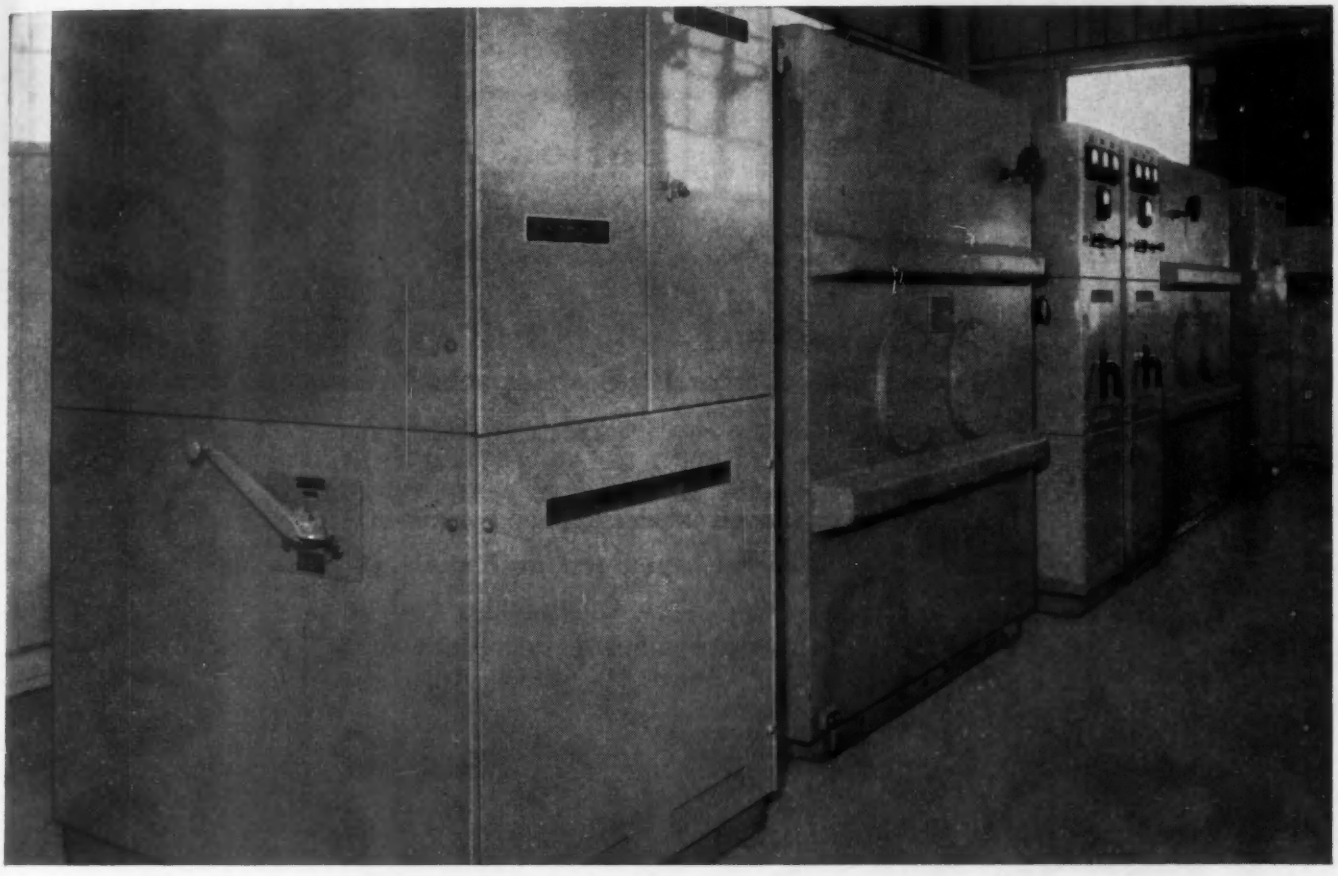
WAGNER TRANSFORMERS . . . THE CHOICE OF LEADERS IN INDUSTRY



Wagner Sealed Dry-Type Transformers can serve under the most adverse conditions

Impervious to DUST, LINT, HUMIDITY, HIGH AMBIENT TEMPERATURES, FLOODING—no need for vaults or barriers

Here's a unit substation transformer that you can safely install in any load center—any place—no matter how tough the operating condition.

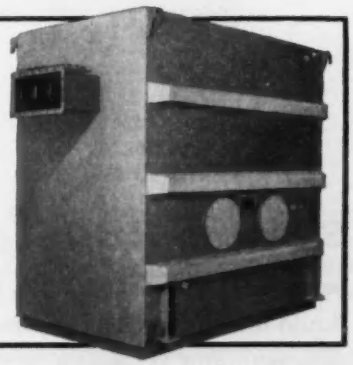
Wagner Sealed Dry-Type Transformers are hermetically sealed in a welded steel case to provide positive protection from contamination, fire and explosion hazards.

Class H insulation is used throughout the transformer. Core and coils are impregnated with silicone varnish and are sealed in the case which contains inert-dry-nitrogen under pressure to prolong insulation life. Maintenance is reduced to periodic checking of bushings case and gas pressure.

Available in ratings from 300 to 2000 kva, 5 or 15 KV high voltage, 480 volts low voltage. For complete information on these sealed dry-type transformers, write for Bulletin TU-214 or call the Wagner branch office near you.

PREDESIGNED
to save you money

Wagner Nitrogen-Filled Dry-Type Transformers save you individual job engineering time and cost. That's because they are PRE-DESIGNED in standard ratings coordinated with the specifications of unit substation switchgear builders. These standard designs assure quicker delivery of the correct transformer for your load center installation.



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SERVING INDUSTRY SINCE 1891

T57-11

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ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

FISHER

Series 2800

Liquid Level CONTROLS

For use as high and low limit switches, to sound alarms, flash signal lights, start or stop fluid transfer pumps, or to operate control valves.

Series 2800

Series 2800 are dependable, inexpensive, snap acting liquid level controls. They are float actuated and, for maximum versatility, are available with either electric (explosion-proof) or pneumatic switch action. Either pilot type is interchangeable on the same float housing assembly. Stab-in type of tank mounting provides easy installation. Available with 4″ iron or steel flanged tank connection. Write for Bulletin F-2800 for complete information.

FISHER GOVERNOR COMPANY
Marshalltown, Iowa • Woodstock, Ontario

for peace of mind when the pressure is on...

...Capitol 3000# and 6000# forged steel couplings

for all high-pressure installations

Full couplings and half couplings are available from stock for prompt shipment in all sizes from ⅛" through 4".

Manufactured to ASTM Specifications A-105.

ORDER EVERY TYPE OF COUPLING FROM

CAPITOL MFG. & SUPPLY CO.
COLUMBUS, OHIO

COUPLINGS — NIPPLES — UNIONS — BUSHINGS — PLUGS — REDUCERS — CAPS—CAPADAPTERS—WELL SUPPLIES

ucts of these two companies are complementary in that much of S.I.E.'s product line requires components such as those produced by Hermetic.

Rector Well Equipment Co. Adds Pilot Plane for All-Weather Flying

A five place twin-engine Beechcraft D185 executive transport airplane equipped for all-weather flying has been added by Rector Well Equipment Co., Inc., Fort Worth, Texas, to increase its service.

John D. Sloman

John D. Sloman has joined the company as pilot. Before coming with Rector, he served as pilot and assistant to the general superintendent. After Danciger merged with Southern Production Company, Sloman was pilot and assistant to the drilling superintendent and later assistant to the production superintendent.

19 Inspect Continental-Emsco Plant at Garland, Texas

Personnel from several companies operating in Hobbs, N. M., and surrounding areas were flown in by chartered plane to make a tour and inspection of Continental-Emsco Company's D + B plant recently.

The group of 19 men made the trip to learn first hand the manufacturing methods used. Primarily designed to manufacture a wide range of D + B sucker rods, sub-surface pumps and other oil field production equipment the Continental-Emsco plant is located at Garland, Texas.

The following men made the tour: J. R. McGovern, Phillips Petroleum Company, C. R. Kersecwa and W. R. Eddington of Gulf Oil Corporation, W. T. Baker and R. J. Christensen of Magnolia Petroleum Company, L. E. Lott of Atlantic Refining Co., L. W. Haney of Warren Petroleum Corporation, A. H. Rice of McAlester Fuel Company, Bill Johnson of Continental-Emsco Co., Lester Williams of L. E. Elliott Co., Bob Hoover of Continental-Emsco, Don Teague and J. Wootten of Texas Pacific Coal & Oil Co., Joe Sherrill of Humble Oil & Refining Company, J. E. Curzon, Phillips, Latham Ryan of Continental-Emsco, Carl Houser of Amerada Petroleum Company, Forrest Woods of Pan American Petroleum Corporation, Lewis Kircher of Amerada, T. J. Thigpen of Pan American Petroleum, and Paul Green of Humble.

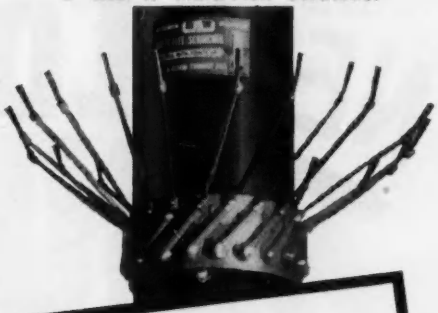
Greeting the plane were Continental-Emsco officials T. H. Fraser, Production Machinery Sales department manager and G. H. Lewis, D + B Sales department manager.

BJ Service, Inc., Opens New Station in Monahans, Texas

BJ Service, Inc., reports that a new company station was recently opened in Monahans, Texas.

This new station, under the supervision of Werner Hartman, offers complete cementing services. Its facilities include a new bulk plant and its equipment fleet includes some of the latest BJ Service

B and W Multi-Flex Scratcher



B and W Inc.
For a good cement job

B and W
Latch-On Centralizer

Also: B and W Multi-Flex Scratcher • Hinged Nu-Coil Scratcher • Rotating Scratcher, Multi-Flex type • Rotating Scratcher, Nu-Coil type • Latch-On Centralizer with Kon-Kave Bow • Latch-On Stabilizer • Stabilock

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6908

NEW LOADCRAFT 808 OIL FIELD FLOAT

HIGH STRENGTH *Feather Weight*

HAS 50,000 POUND CAPACITY

SPECIAL FORMULA 808 STEEL PROVIDES ULTIMATE IN WEIGHT-STRENGTH RATIO

Now, here's an all new heavy-duty oil field trailer that actually weighs less than conventional trailers, yet it rated for as much as 5 tons more payload. This great buy will actually pay for itself with extra earnings from time and trips saved, but you pay no more than for an ordinary trailer. It is made entirely of special formula 808 steel with full 18" deep frame and 9" outer rail. It is designed for three point stability in nose loading . . . has oversize rolling tail pipe with self-aligning bushings for rear loading. Equipped with new Loadcraft combination bar-spring tandem.

A RUGGED PERFORMER

This baby has the guts for the biggest jobs. It has been scientifically designed . . . fully field tested.

WRITE FOR LITERATURE AND PRICES

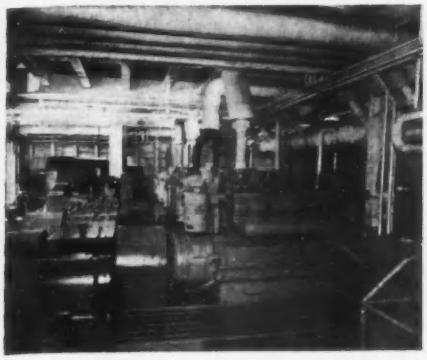
Dealer Inquiries Invited

Spencer-Safford LOADCRAFT INC.

PHONE 1082 AUGUSTA, KANSAS

high-pressure, high-volume cementing units.

The new Monahans station is part of a broad BJ Service expansion program designed to open new stations and provide additional facilities for faster, more efficient services to the industry.



Diesel on Vinegaroon

Powering the mud pumps, drawworks and rotary table of the Vinegaroon, Zapata Offshore Company's offshore rig drilling for Sun Oil Company at the present, are these four Caterpillar D397 turbocharged Diesel engines. Equipped with Twin-Disc torque converters, these engines each generate 520 (intermittent) horsepower at 1200 revolutions per minute. All drilling equipment on the Vinegaroon, except the catworks unit, is located beneath the drilling platform, where it is protected from the weather.

U. S. Rubber Wire and Cable Sold to Kaiser Aluminum

The wire and cable business of United States Rubber Co. was sold to Kaiser Aluminum & Chemical Corp., it was announced by the board of directors of the rubber company. The sale, which was for cash, became effective February 1. It will include the plant, property and equipment in Bristol, R. I., H. E. Humphreys, Jr., chairman, announced. In addition, Kaiser Aluminum will take over U. S. Rubber's wire and cable inventories, sales organization and distribution network.

"The 1400 employes of our Wire and Cable department will be transferred to the Kaiser Aluminum organization," said Humphreys. "They will maintain the same or equivalent employe benefits—such as pensions, vacations and various insurance benefits."

Humphreys said U. S. Rubber has been considering getting out of the wire business for some time, since it is more closely allied to the metals field than to the rubber industry. He added that the company expects to continue to supply the rubber used for wire insulation at the Bristol plant.

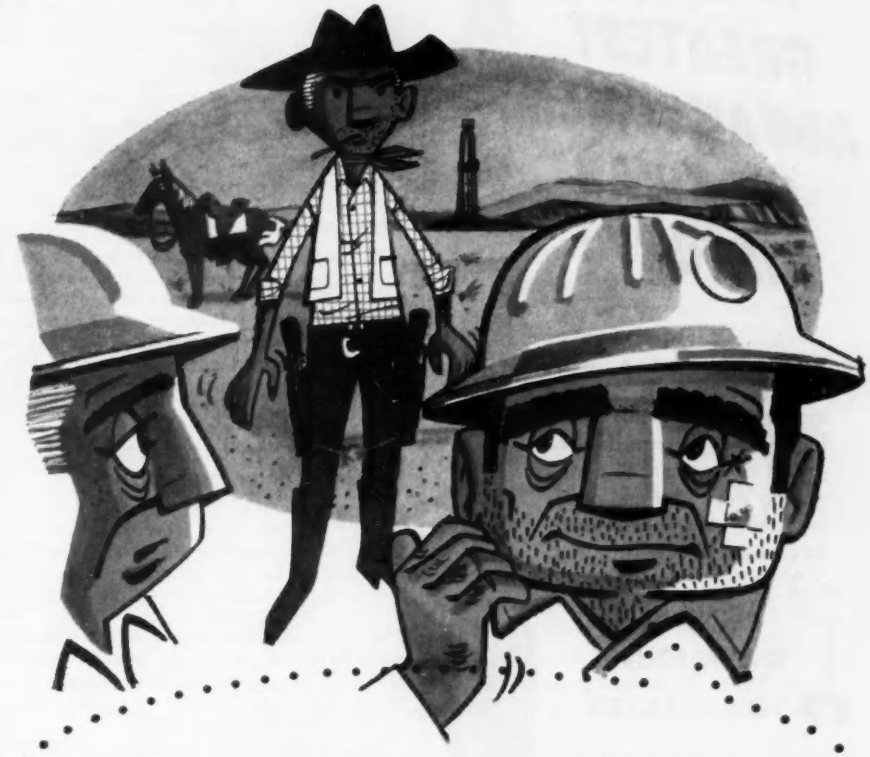
U. S. Rubber has produced insulated wire and cable at the Bristol plant since 1892.

Trans-Gulf Offshore Platform Will Feature Ideco Rig

A streamlined new concept in offshore platforms is projected by the newly formed Trans-Gulf Drilling Company.

The drilling platform features a full-view mast; two 1250 horsepower mud pumps, and other equipment built by Ideco, one of the Dresser Industries. Unique features is single hull, inside of which is located most of the machinery.

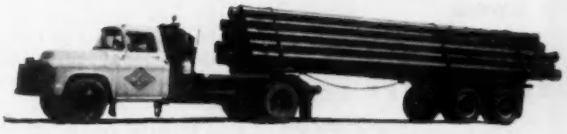
Congrats and $25 to O. C. IRVINE, P. O. Box 1407, Shreveport, La., for this quip.



Oil industry authorities forecast more wells and more footage as the year progresses ... over 59,296 new wells are expected in response to spiraling demands for oil.

Lone Star Steel is completely attuned to this new tempo ... and is rushing construction of a new open hearth furnace and stretch-reducing mill. Eventually, Lone Star will produce more fine steel ... and more fully-normalized API casing, tubing and line pipe for our friend and neighbor, Joe Roughneck, heart of the oil and gas industry. Depend on Lone Star ... because Lone Star is on the grow!

Neighbor, wherever you are, specify Lone Star and we both get a good deal.



Lone Star STEEL COMPANY

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For more data on advertised products, use Readers' Service Cards, last page.

GREATEST ADVANCEMENT IN SWAB HISTORY!

The Oil States Swab is the most advanced swab on the market having been developed and perfected after years of research, painstaking work and engineering skill. It's acceptance has been overwhelming.

HERE ARE THE FEATURES YOU WANTED

★ Fewer cups to handle ANY job

★ NO Servicing

★ Responds to lightest loads

★ Swab can be EASILY UNLOADED at any time

★ Valve action from base of cup

★ Perfect for swabbing following frac jobs

★ Only 6 parts Required to Assemble a 2-Cup Swab

SOLD THROUGH SUPPLY STORES EVERYWHERE

(CUTAWAY)

Oil States

OIL STATES RUBBER CO.
ARLINGTON, TEXAS

The James Bowie

The James Bowie, first of three 132 feet by 34 feet and by 10 feet 6 inches towboats built by American Marine Corporation for Commercial Transports of Houston was formally accepted by its owners at dedication ceremonies recently in New Orleans. It was built to American Bureau of Shipping requirements.

Tom Eakin Service to Distribute For Grant and MacClatchie

Tom Eakin Oil Tool Service of Willows, Calif., has acquired the Northern California distributorship for Grant Oil Tool Company and MacClatchie Manufacturing Company oil field drilling and production equipment. Tom Eakin, who heads the distributing firm has spent the past 30 years in the oil business with 16 of those years working for the major oil companies. He started his own supply company about a year ago.

The Grant and MacClatchie line includes a complete line of stabilizing tools, reamers and fluid-end pump parts as well as a full line of production equipment.

Byron Jackson's Pampa Office To Service Texas-Oklahoma Area

To expedite service to the oil industry in the northern Texas and southern Oklahoma area, Byron Jackson Tools, Inc., has opened a sales and service office in Pampa, Texas.

The new Pampa office will be managed by James Deaton who was, until recently, in charge of the Wichita Falls, Texas, office. The latter office will be managed by H. Frank Smith. The Pampa and Wichita Falls offices are under the direction of regional sales manager, R. J. Evans, Jr.

Graver Tank Celebrates 100th Anniversary With Contest

Graver Tank and Manufacturing Co., Inc. is celebrating its one hundredth anniversary this year. The company has grown from an organization that employed only the two Graver brothers, who founded the firm, to the more than 4000 people employed today in plants and divisions across the country. The company was also the first industrial concern to move into the East Chicago-Gary-Hammond district, which today probably has a more dense concentration of heavy industry than any place in the world.

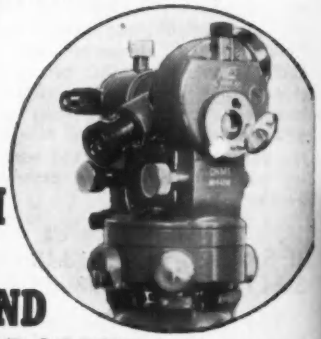
Willard M. Broxham, Graver vice president and centennial chairman, announced that Graver will offer prizes for information as follows: (1) where is the oldest Graver tank still in use; (2) who has the oldest picture of a Graver tank and (3) the best idea of decoration of a Graver tank or tanks (either in existence or planned). Broxham gives the hint that the first products were probably fabricated in the Pittsburgh area and there is indication in company records that their earliest products were probably office safes (no longer manufactured by Graver).

*IN TEXAS ...AND THE WORLD OVER

KERN SURVEYING INSTRUMENTS

*The Bridge Division of the State of Texas Highway Dept. uses Kern Instruments

WORLD FAMOUS FOR
Working Speed
Operational Simplicity
Accuracy & Economy



DKMI TEN SECOND THEODOLITE (*with optical micrometer*)

- Exceptional portability and precision.
- Readings automatically ... AT A GLANCE.
- Direct reading to 10". Estimation to 1". Average working accuracy —3-4 secs.
- Can be used with electric lighting unit for night work.

KERN CENTERING TRIPOD

Unique—a Kern first! Centers instruments in seconds with remarkable accuracy. Assures exceptional stability with ball-and-socket head, supporting instrument coupling.

★

Write for Brochure DK 518 - 8

PROMPT, RELIABLE SERVICE
FACTORY TRAINED PERSONNEL

Kern SWISS

The FINEST in SURVEYING EQUIPMENT

KERN INSTRUMENTS INC.
120 Grand St., White Plains, N. Y.

Thank you, Mr. Westby... *for reporting to us the amazing drilling record your crew established with one of our Failing Holemaster Rigs:*

Over 70,000 feet of hole in ONE MONTH!

Mr. G. H. Westby, President of the Seismograph Service Corporation of Tulsa, describes their drilling experiences with Failing Rigs in Egypt:

"Our records for the month of February, 1955, on our Egyptian crew," writes Mr. Westby, "show that one of our drillers, Dewey Ramsey, drilling with a Failing CFD-1 drill, completed a total of 70,335 feet of hole. This, we feel, is an outstanding example of what can be done by one driller and one drill, and we are quite proud of this accomplishment.

"This was in connection with work in Egypt which we were carrying out for Sahara Petroleum Company in the Qattara Depression. **Drilling in this sandy area was relatively easy but patterns of 20 to 35 holes each were required, each hole being drilled to Kelly depth. Our three Failing CFD-1 drills, each being operated by one American driller with two Egyptian helpers, were completing a pattern in approximately nine minutes.**

"We feel we are justified in being proud of this month's drilling operation; however, we are also pleased with our over-all drilling accomplishments in Egypt. We began operations in mid-July, 1954, with three Failing CFD-1 drills, and we continued with these drills through October 28, 1956, when the Suez situation forced our evacuation. **During this period, most of our drilling was in hard limestone, under conditions similar to those encountered on the Edwards Plateau, yet the drills averaged approximately 43,000 feet per month for the entire period.**

"During 1956 our drill power was augmented by the addition of two new Failing CFD-1 drills under the direction of drillers J. M. Russell and R. M. Underwood, and these, too, were doing a remarkably good job. **Your good drills and our good drillers made a working combination of which we can all be proud."**

Seismograph Service Corporation
TULSA 1, OKLAHOMA, U.S.A.

Mr. H. J. Godschalk, Advertising Manager
George E. Failing Company
Enid, Oklahoma

Dear Mr. Godschalk:

After receiving your letter of November 16th, we had intended to have the information you desired with regard to our drilling in Egypt come direct from that division, but because of the excitement caused by the evacuation of the crew from Egypt shortly thereafter, the matter was inadvertently overlooked.

Our records for the month of February, 1955, on our Egyptian crew show that one of our drillers, Dewey Ramsey, drilling with a 1954 Failing CFD-1 drill, completed a total of 70,335 feet of hole. This, we feel, is an outstanding example of what can be done by one driller and one drill, and we are quite proud of this accomplishment.

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These original three drills were operated by D. M. Ramsey, L. D. Hamner, and I. G. Lair. All three drills were going strong at the time of evacuation. Aside from the normal amount of repairs made during the period, the only change made on these drills was the addition in mid-1956 of your fluid-motor pull-down conversion kits.

During 1956 our drill power was augmented by the addition of two new Failing CFD-1 drills under the direction of drillers J. M. Russell and R. M. Underwood, and these, too, were doing a remarkably good job.

Your good drills and our good drillers made a working combination of which we can all be proud.

Very truly yours,

SEISMOGRAPH SERVICE CORPORATION

G. H. Westby, President

GHWad

Actual photo of Failing rigs doing pattern shot hole drilling in Egypt.

WHEREVER YOU DRILL . . . whether it's pattern shot-hole work, coring, shallow production or other drilling projects . . . you can always depend on FAILING rigs for outstanding, dependable service! Send for informative Failing bulletins now.

GEORGE E. FAILING COMPANY

GEORGE E. Failing COMPANY

A SUBSIDIARY OF WESTINGHOUSE AIR BRAKE COMPANY

ENID, OKLAHOMA, U.S.A.

You can get D+B

No Wonder

More and More Experienced Operators Demand D+B Pumps, D+B Parts and D+B Pump Shop Service— Backed by 50 Years of Know-How

Complete flexibility and adaptability to any type of job —deep or shallow—under sandy, corrosive, gassy, crooked or slant hole conditions is available with D+B Precision-Built Pumps, which can be "customized" for your needs from standard D+B Parts. Get the full story from your nearest Continental-Emsco Store and learn about prompt pump shop service available in every major producing field.

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

D+B
- DEEP WELL PUMPS
- SUCKER RODS
- COUPLINGS

CONTINENTAL-EMSCO COMPANY

A Division of The Youngstown Sheet and Tube Company

General Offices: DALLAS, TEXAS • Plants: LOS ANGELES • HOUSTON • GARLAND, TEXAS

Export Division: 45 Rockefeller Plaza, New York, N. Y.

Representatives in All Principal Oil Fields of the World

"CUSTOMIZED" PUMPS

made in 700 combinations from standard

D+B *parts to fit your needs!*

Rod Full Barrel with Cup Hold Down
¾" Bore Stripper Pump with 3-Cup Bottom Hold Down
Rod Sectional Liner Pump— Stationary Barrel with Simplex Top Lock
3 Tube Pump Regular Type
Rod Liner Pump— Traveling Barrel with Simplex Bottom Lock Hold Down
Tubing Sectional Liner Pump with Reed Standing Valve Puller Plunger Bottom Valve and API Bottom Lock— Hold Down and Shoe
Stationary Barrel with Simplex Bottom Lock Hold Down

BE SURE TO SEE
that it's
K&G
WHERE YOU GET ALL
THREE
• DRILL PIPE JUNK SHOT
• MAGNETIC FISHING TOOLS
• DIAMOND CORE BARREL MAGNET

K & G MAGNETIC
FISHING TOOL

Available
in
popular
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from
most
fishing
tool
companies

K & G A-100
DRILL PIPE
JUNK SHOT

BE SURE TO SEE
That It's
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designed, developed and manufactured by the pioneers of first successful magnetic fishing tools . . . the ONLY company licensed to manufacture under U. S. Patent No. 2,668,077

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BARREL MAGNET

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BRANCH OFFICES—CALIFORNIA: Avenal, Bakersfield, Long Beach, Los Angeles, Ventura. ILLINOIS: Olney. KANSAS: Great Bend, Liberal. LOUISIANA: Lake Charles, Jennings, New Iberia, Houma, Harvey. NEW MEXICO: Farmington, Hobbs. OKLAHOMA: Healdton, Oklahoma City. TEXAS: Abilene, Andrews, Bay City, Beaumont, Borger, Brownfield, Corpus Christi, Edinburg, Houston, Kilgore, Odessa, San Angelo, Sherman, Snyder, Victoria, Wichita Falls. WYOMING: Casper.

All information and pictures must be mailed to the Centennial committee, Graver Tank and Mfg. Co., Inc., East Chicago, Ind., before November 1, 1957. The prizes of $100 each are offered to the person who finds the oldest tank in use and the person who finds the oldest picture of a Graver product. A $500 prize and two $250 prizes are being given for the best idea or actual decoration of tankage facilities, whether it be industrial, commercial or municipal. The prize winners will be named in Chicago at the American Petroleum Institute convention in November.

Bucyrus-Erie Names Jameson Manager of Drill Division

Bucyrus-Erie Company has announced the appointment of Henry M. Jameson as general manager of its Drill division, with headquarters at Richmond, Ind. The company is building a new plant, which will be completed in early 1958, and will provide 300,000 square feet of floor space for the manufacture of Bucyrus-Erie's complete line of oil well spudders and water well and blast hole drills.

Jameson joined Insley Manufacturing Company in Indianapolis, and later was associated with the Allis Chalmers Manufacturing Company. In 1937 he joined Bucyrus-Erie as tractor equipment sales manager.

The company will open a headquarters office for the Drill division in Richmond in the near future. Construction of the new plant is being handled by the H. K. Ferguson Company of Cleveland, Ohio.

General Electric Organizes Applied Mechanics Group

An applied mechanics engineering group headed by H. J. Siekmann as newly-appointed manager, has been formed at General Electric's Metallurgical Products department, Detroit.

According to J. S. Gillespie, manager of engineering, the new specialized unit, as part of the engineering section, will be responsible for obtaining basic information on physical properties, machinability, fundamental application requirements and for performing stress analyses to guide material development. It also will help establish design and application criteria.

Siekmann for the past three years was in charge of the department's machinability laboratory. He was responsible for much of the test and machinability data developed recently on the newer Carboloy cemented carbides and cemented oxides.

U. S. Steel's New Branch Store To Service Four Corners Area

The opening of a new branch store at Farmington, San Juan County, N. M., by U. S. Steel's Oil Well Supply Division was announced. The new store and a realignment of regional responsibility within the company's management structure have been accomplished for the purpose of providing field and store service in the Four Corners region.

The following eight counties in northwestern New Mexico will be transferred from the Central Midwest area to the Rocky Mountain area: San Juan, Rio Arriza, McKinley, Sandoval, Los Alamos, Santa Fe, Valencia and Bernalillo. At the same time, Apache County in northeastern Arizona will be transferred from the California area to the Rocky Mountain area.

FOR
SWABBING
KING
WIRE LINE
STRIPPER
Finest in the field. King strippers represent outstanding advances in design and construction that assure long life and maximum operating efficiency.

• POSITIVE LATCH will not release by accident or surge of pressure.
• SURE RELEASE MECHANISM operated by rope socket striking bottom of the stripper.
• NON-SPARKING MATERIALS minimize fire hazard.
• ROLLER WIRE LINE GUIDES on hardened steel pins.
• SIDE OPENINGS for inserting packing while line is in the hole.
• PACKING IS SELF-CENTERING; compression screws need not be evenly adjusted.
FOR
DEEPEST
SLIM-HOLE
DRILLING
AND
WORKOVER
RIGS
40 and 50 KG SWIVELS

Replacing the King 40 and 50 XV Swivels, the KG Series features new washpipe and packing arrangement which permits Higher Speed Rotation Change of Packing without "Breaking Out"
NOTABLE FEATURES:
• New washpipe-packing box arrangement simplifies packing change, eliminates thread-galling.
• Zerk Fitting assures easy lubrication of Chevron or V-type packing.
• Oversize watercourse makes KG Swivels ideal for drilling by conventional and reverse circulation methods.
• Compact; strength with minimum weight.
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By Glenn Taliaferro
Johnston Testers

FOR MORE INFORMATION AT THE BOTTOM OF YOUR WELL

FIVE Important Points of D. S. T. Pressure Charts

The science of reservoir engineering is putting greater demand on the field engineer for understanding and interpretative knowledge of Drill Stem Test Pressure Charts. Technical reservoir information can be enhanced by utilizing drill stem test data.

Realizing there is a need for proper evaluation of such data, Johnston Testers is complying by furnishing to the industry a pressure chart combining both "expanded" time and "expanded" pressure. Figures A and B illustrate the same chart, Figure A having the advantage of "expanded" time and "expanded" pressure to aid in the interpretation. By placing Figure A on a *reduced time* scale and removing the *extra inches* of deflection Figure B is produced.

Although Figure A presents a rather complicated appearance, it is simplified by realizing that

1. The chart progresses from right to left and that
2. When a pressure line reaches the left extremity of the chart it will reappear AT THE SAME PRESSURE READING ON THE RIGHT SIDE.

Points of interest on Figure A

1. Initial hydrostatic mud pressure.
2. Initial flowing pressure.
3. Final flowing pressure.
4. Final shut-in pressure.
5. Final hydrostatic mud pressure.

Reading from right to left, the pressure chart indicates the build-up hydrostatic pressure as the testing assembly is lowered in the hole. Upon reaching bottom the initial hydrostatic head of the mud column is recorded in pounds per square inch as indicated at point "1".

With the testing assembly on bottom, weight is applied and the packer is expanded isolating the desired test zone.

After the packer expands, the test tool opens exposing the test zone to the conditions in the drill pipe. This allows the pressure to drop from the initial hydrostatic mud pressure at point "1" to the initial flowing pressure at point "2" and with this decrease of pressure on the test interval, the fluid in the formation is permitted to flow into the well bore.

As the fluid flows from the formation through the perforated anchor and into the drill pipe, the pressure recorders accurately record the increase of pressure from the initial flow pressure at point "2" to the final flow pressure at point "3".

Any changes in pressure during the flow period will be recorded whether they are caused by tool manipulations or formation characteristics and will be easily identified on the flow curve. Examples of these pressure changes during the flowing period could be changing chokes at the surface, partial or complete plugging during the test, operating the equalizing valve to unplug the test tool.

After the well has been flowing for the desired length of time, the shut-in valve in the testing assembly is closed by rotating the pipe to the right. The small volume in the tester assembly from the shut-in valve to the bottom of the hole allows a rapid build-up toward the formation or reservoir pressure and the final shut-in pressure is recorded at point "4".

After the shut-in period is completed the equalizing ports are opened, allowing the mud to flow below the packer, facilitating easy removal of the packer from the packer seat. As the mud equalizes below the packer, the pressure increases to the final hydrostatic mud pressure at point "5" and as the tester is removed from the hole the chart shows the decrease in pressure and returns to the base line as the test tool reaches the surface.

All the pressures measured and recorded are due to the "actions" of various fluids encountered or controlled by the Tester. Mechanical operations, such as sudden changes in running speed, jarring, and so on, will record as vertical lines (pressure) very short time intervals. These lines will not confuse the actual test pressures as they are readily recognized as forces other than those caused by the formation.

For more comprehensive interpretative data write Johnston Testers for the booklet entitled "The Interpretation of Drill Stem Test Data."

FIGURE B

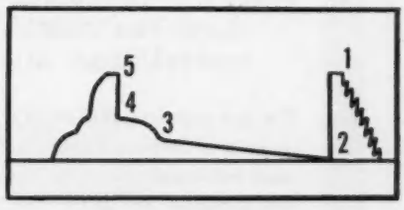
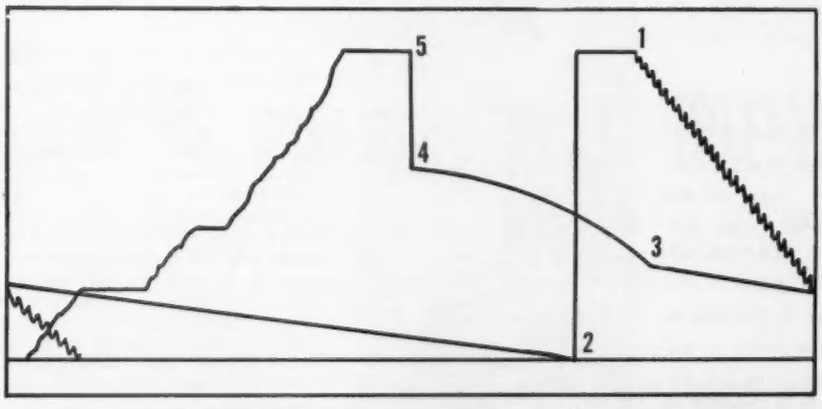
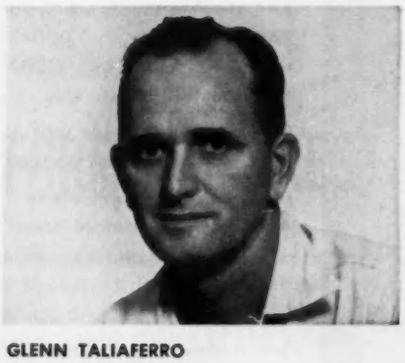


FIGURE A





GLENN TALIAFERRO
Manager of Chart Dept.
Johnston Testers
Houston, Texas

JOHNSTON TESTERS

A Subsidiary of Schlumberger Well Surveying Corporation

first in drill stem testing

HOUSTON, TEXAS

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PERFECT SEAL
unions
give a 3 to 1
safety factor
PLUS
A PERFECT SEAL!
THERE'S A CATAWISSA PERFECT SEAL UNION FOR EVERY USE . . . ALL TEMPERATURES, ALL PRESSURES!
The full dependability of HOT FORGED STEEL is yours in a Catawissa Union (hot forged from solid steel bars) with several extra value features that are exclusive here at the UNION SPECIALISTS!
All Catawissa Unions are designed to give a 3-to-1 SAFETY FACTOR . . . 3,000-lb. service unions are tested to 9,000-lbs., 6,000-lb. service unions tested to 18,000-lbs., etc.
Exclusive Ball-to-Angle seat design assures a PERFECT SEAL even when the pipe is not in alignment!
Machining operations assure a UNIFORMITY AND ACCURACY heretofore found only in special fittings and, with rigid inspection both during and after machining, guarantees LEAKPROOF CONSTRUCTION!
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AVAILABLE FROM LEADING INDUSTRIAL SUPPLY FIRMS
CATAWISSA VALVE & FITTINGS COMPANY
60 MILL STREET ★ CATAWISSA, PENNA.

The Ramrey III carries small supplies to and from offshore oil drilling locations near Venezuela.

Equitable Equipment Builds Speedy Diesel Water Taxi

The new Equity 32-foot water taxi has attained speeds of 38.2 miles per hour in its trial runs; thus making it the fastest all steel, diesel propelled boat of its type in the world. The speed was checked over the measured mile in Lake Pontchartrain.

The water taxi or crew boat was built by Equitable Equipment Company, Inc., of New Orleans and will be delivered to Compania Ramrey Internacional S.A. of La Guairia, Venezuela.

The "Ramrey III" will be used for oil field crewboat operations in Venezuela.

Shaffer Tool Works to Build Warehouse in Houma, La.

Shaffer Tool Works of Brea, Calif., announced that their company will start immediate construction of an office and warehouse building in Houma, La. The new warehouse and office building will be located on U. S. Highway No. 90, Houma approximately 50 miles west of New Orleans.

The construction contract for this new shop was awarded to Gulftide, Inc., Louisiana industrial contractors. Actual construction will commence immediately and completion is anticipated around the end of April.

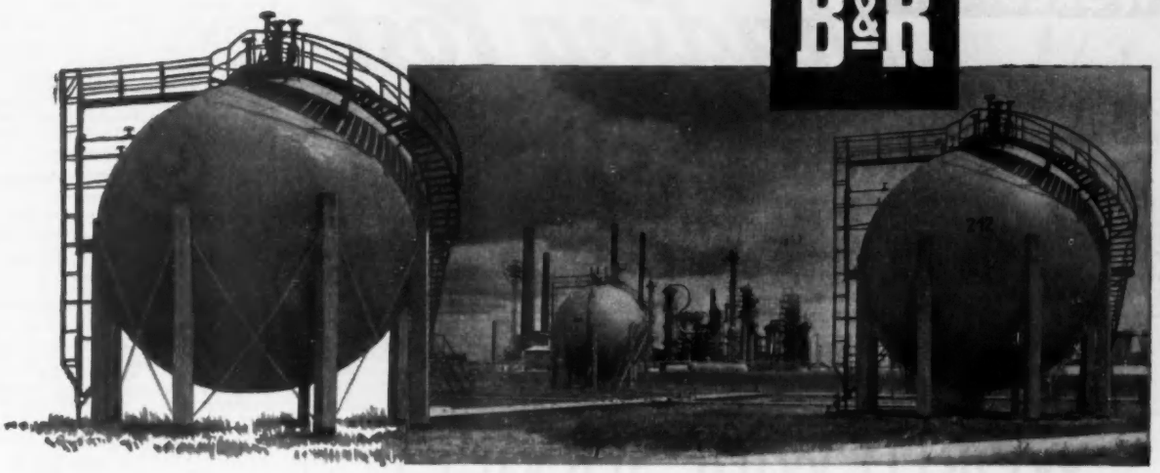
Shaffer Tool Works has been identified in the Louisiana area for several years. The new shop installation at Houma will supplement their existing facilities to serve the oil and gas industry for sales and service of Shaffer oil tools for the Gulf Coast area. James E. Plemons is the district manager for the Louisiana area.

Raybestos Manhattan Develops National Workshop Meeting

Nearly 100 Raybestos-Manhattan executives and representatives of sales and engineering from several divisions were recently informed on ways of increasing usefulness of industrial rubber and mechanical packings and how industry will benefit. This 1957 National Sales Workshop was the largest group ever assembled for an R/M Sales-Engineering session. It was a week-long combined meeting of Industrial Rubber and Mechanical Packing divisions convened in the Statler Hotel in St. Louis. The workshop took the form of daily panel discussions with many representatives participating.

The formula, developed by R. B. Hazard, vice president and sales manager for the Industrial Rubber and Mechanical Packing divisions, was built around the word "know." The slant was a reversal from the usual "how to sell." Instead, every phase of the five-day workshop was devoted to instruction in how best to help industrial users.

B&R



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in many countries successfully equipped their modern plants with B&R Gate Valves, Globe Valves, Swing Check Valves, Safety Valves. B&R Valves are manufactured according to API specifications. Flange dimensions conform to ASA. Materials correspond to ASTM. One trial with our Valves will make you our customer for ever. Please ask for B&R catalog We 110e with detailed particulars on our lines of **oilfield and refinery equipment.**

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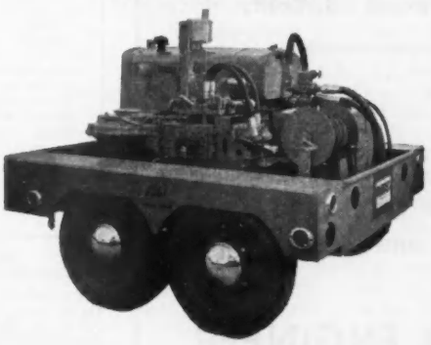
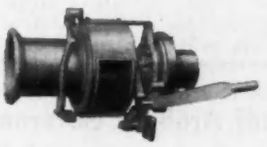


CATHEADS FOR EVERY NEED



Foster BUILDS BEST to OUTPERFORM THE REST

Foster Cathead Company devotes full time and attention to the designing and building of finer equipment for the spinning and breakout of pipe. Foster Catheads and Foster Tubing Tongs are the result of our 31 years in this field exclusively. It will pay you to investigate the performance, endurance, economy, and safety that make Foster products, since 1926, "first choice of the industry."

All Foster Representatives carry a complete inventory of spare parts for tongs and all models of Foster Catheads

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R. D. Cloninger ..... Lafayette, Louisiana
L. W. Mauck ..... Great Bend, Kansas
W. O. Nelson ..... Farmington, New Mexico
Coastal Engineering Co. ..... Bakersfield, California
Moore Sales & Service Company ..... Casper, Wyoming
Joe Perry ..... Salem, Illinois
T. C. McDonald ..... Shreveport, La.

Bobby Gill ..... Duncan, Okla.
Leidecker Tool Co., Ltd. ..... Edmonton, Alberta, Canada
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The Saudi Arabian Government is open to engage on an eighteen month contract fully qualified and mature American or Canadian

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Write for application form to:
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All applications and data submitted will be kept in strict confidence.

HELP WANTED

Management Opportunity in Latin America LP-Gas man needed who has experience in management of direct retail and dealer sales, as well as bulk plant administration and operations. Prefer man who has lived in Latin America and has a good knowledge of the language and customs of that area. Wonderful opportunity for the right man. Age 35-45 preferred. Provide complete resume of background. All communications confidential. Box No. 130-W., WORLD OIL, Houston, Texas.

POSITION WANTED

■ PURCHASING-ADMINISTRATIVE: Ten Years Oilfield Supply Company; Twelve years Major Oil Company. Two jobs in Twenty-Two Years. Age 41. Currently Employed Out of State; Desire Relocation in Houston. Excellent Qualifications; Excellent References. Box 131-W, WORLD OIL, Houston, Texas

■ Geophysicist eighteen years of interpretative and supervisory experience, of which fourteen were spent in Latin America, desires position of greater responsibility in foreign oil exploration. Box 129-W, WORLD OIL, Houston, Texas.

FOR SALE

FOR SALE
TWO COMPLETE DRILLING RIGS
NATIONAL—110—purchased Aug. 1955
CLARK—PR-1,000
Both rigs complete in every detail—inventory on request. Have been drilling W. Tex., now stacked. H. R. Dickerson, Pres., Sabine Drilling Co., 814 Commercial Nat. Bk. Bldg., Shreveport, La., Phone: 3-5285.

BUSINESS SERVICE

■ Delaware Corporations formed and servced. Inquire without obligation. American Guaranty & Trust Company, 910 West Street, Wilmington, Delaware.

Well organized, well established oil-well drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire or call collect for further information.

MAKIN DRILLING COMPANY
P. O. Box 1628
Hobbs, New Mexico
Phone: EXpress 3-3141

BUSINESS OPPORTUNITIES

■ TANK TRUCK OPERATION (Statewide) S. Calif. Est. 25 yrs. No road restric! Accts w/the Navy & lge oil cos. Four,-$35,000 trucks incl. Nets over, $11,000. Write for brochure and photo. Ref. 24267

■ Whlse & Retl FUEL OIL & GAS. DISTRIB. Lewes, Delaware. 1956 gals-750,000. 350' x 350' w/8 bldgs, incl. liv. qtrs! Close to major oil refin. Easy haul. w/compl. fac. & delivery eqpt. Tank cap.-335,000 gals. Est. '39. Unlimited potential oppty. Write for details! Ref. 42528

■ OIL CO & APPLIANCE STORE: No. N. H. Sells 500,000 gal. yearly. $14,000 net income. Ideal for man & wife. $18,150 Dept 42456

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6425 Hllwd Blvd., Los Angeles Calif.

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VENEZUELAN OIL
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Periodic operations reports (industry-wide)—Maps—Newsletter
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J & L Moves Sales Office In Fort Worth to New Building

Rainey Elliott, president of Jones & Laughlin Supply division headquartered in Tulsa announced the recent move of the firm's Fort Worth, Texas, sales office to 2006 Continental National Bank Building.

Sales personnel based in the Fort Worth office, formerly located in the Continental Life Building, include R. Z. Dallas, office manager, and Rawley Angerstein, sales representative for the Fort Worth area.

Otis Pressure Opens Office in Farmington, N. M.

Otis Pressure Control, Inc., has opened a district office at 1705 Chochite Street in Farmington, N. M. Byron (Pete) Levisay is in charge of the new branch. Prior to joining Otis, Levisay was with Magnolia Petroleum Company for several years.

Otis has maintained a branch in New Mexico for 20 years, first opening in Hobbs in 1937. New Mexico facilities are under the company's Western division in Odessa, Texas. Jack Russell is the division manager in Odessa.

Atlas Exploration Co. Becomes Atlas Laboratories, Incorporated

The name of Atlas Exploration Co., Houston, has been changed to Atlas Laboratories, Incorporated, to reflect more accurately the nature of the company's activities.

At the same time, it was emphasized that all officers will remain the same and that the company will continue to produce and market its advanced line of gravity meters and gas detectors.

The company revealed recently its plans to distribute an improved gravity meter designed especially for oil and mineral exploration. The Atlas line of gas detectors includes instruments for use in drilling operations and in pipe lines, plants, boats and other areas where excessive gas or other hydrocarbon vapors can constitute a hazard, or where determination of the presence of hydrocarbons is necessary for exploration purposes.

Tretolite Creates 2 Divisions; West Central and Northwestern

The Tretolite Company Division of Petrolite Corporation announces a reorganization and expansion of their sales and service staff. The Tretolite Company manufactures chemicals and services for the petroleum industry. The reorganization involves the creation of two new service divisions. One, the Northwestern, will comprise western Kansas and Oklahoma and the Texas Panhandle area. The other will be known as the West Central, and will take in the West Texas and New Mexico fields.

J. B. Robinson, formerly assistant manager for the Northern division, will be manager for the Northwestern division. He will make Great Bend, Kansas, his headquarters; his assistant manager will be H. R. Land.

The new West Central division will be managed by J. L. Hampton, formerly manager of the Rocky Mountain division. His assistant manager will be R. Q. Hughes. They will have their headquarters at Midland, Texas.

The Rocky Mountain division will now be managed by L. C. Dessert, with R. O. Byron and John Stewart as assistants. Dessert was formerly affiliated with the home office district of Tretolite Company, as assistant chief chemist. His headquarters will be Casper, Wyo.

The Southern division, comprising the Texas-Louisiana Gulf Coast area will be supervised by L. A. Bainter, Jr., with O. L. Bassham, P. R. Donnelly and W. M. Robertson as assistants. Bainter will make Houston his headquarters. C. C. Rogers, Jr., former manager has moved to a special assignment with the Petrolite Corporation. He will make San Antonio, Texas, his headquarters.

Harry S. Horton, with headquarters at Tulsa and M. J. Mullally, with headquarters at Dallas will continue to supervise the Northern and Central divisions respectively.

The first shipment of barite to Magcobar.

Magcobar Gets First Shipment Of Greek Barite in New Orleans

The first shipment of barite from the new Greek mining and shiploading facilities of Magnet Cove Barium Corporation has arrived at Magcobar's New Orleans plant. This initial 10,000 tons of barite will be processed for use as heavy weight material for drilling mud.

The availability of drilling mud is one of the key factors in the continuing success of the oil industry, as the drilling rate is constantly increasing in this country and abroad. The Louisiana offshore drilling boom particularly has increased the demand for drilling mud. Regular shipments of barite from the Mykonos mine will follow this first 10,000 tons.

Magcobar has 20 different mining and milling operations in seven states and in three foreign countries.

Electro-Technical Labs Moves Into New Plant in Houston

Doyle D. Mize, president of Electro-Technical Labs., division of Mandrel Industries, Inc., announced that the company has moved to its new plant at 5134 Glenmont Drive, Post Office Box 13243, Houston.

The new, half-million dollar plant encompasses more than 35,000 square feet.

Electro-Technical Labs. manufactures geophysical equipment used primarily in oil exploration throughout the world. The equipment is sold to foreign markets through two sales agents: Electro-Tech International and Electro-Technical Labs., Alberta Limited.

United States Rubber Buys Into British Tire Manufacturers

United States Rubber Co. has acquired a substantial minority interest in Englebert & Co., tire manufacturers in Europe, located at Liege, Belgium, H. E. Humphreys, Jr., president, announced.

Through this acquisition, Humphreys said, U. S. Rubber will now have facilities available for the manufacture of U. S. Royal tires in Belgium, France and Germany in modern plants favorably located with respect to major European automotive manufacturers and the European plants of American motor companies.

Established 54 years ago, Englebert & Co. is one of the pioneers in the European tire industry. It operates three plants located in Liege; Aachen, Germany, and Clairoix, France; which are currently being expanded. U. S. Rubber is supplying research and development assistance to Englebert under technical service agreements.

Mission Mfg. and Rives, Dyke Awarded for Advertising

The Mission Manufacturing Company and its advertising agency, Rives, Dyke and Company, both of Houston, have received top level recognition for its business-paper advertising through an Award of Merit presented recently as the climax of Associated Business Publications' twelfth annual advertising competition.

The Award was accepted by Jack Faris, New York, Mission's export manager, at a luncheon in the Ballroom of the Military Park Hotel, Newark, N. J.

More than 500 advertising campaigns were submitted in the competition.

The Mission Manufacturing Company-Rives, Dyke achievement was in Division 2. This category included the advertising of maintenance and service equipment, parts and materials. Mission Manufacturing Company and Rives, Dyke also won the award in 1953.

A Better Traveling Block

for Every Purpose

40 — 500 TONS

Extra weight and balance for "non-wobbling" falls.

Johns-Manville "Klipper" grease seals.

Easy opening guards, no bolts to take out and lose.

Extra large bearing diameters.

Divider plates between each sheave, eliminates center pin deflection.

McKISSICK

McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

SQUEAKS from the BULLWHEEL

"They're drilling quite close to our property." WORLD OIL

Definition

A philanthropist is a man who gives his money to grateful strangers so that his family won't have to argue over it.

Modern Goldilocks

Papa Bear: "Someone's eaten my porridge."

Baby Bear: "Somebody's eaten my porridge, too."

Mama Bear: "Keep still, you idiots. I haven't served it yet."

Some Alarm!

"Aha," said the head clerk, "I'm glad to notice that you're arriving punctually now, Mr. Slocombe."

"Yes, sir. I've bought a parrot."

"A parrot? What on earth for? I told you to get an alarm clock."

"Yes, I know, and I did. But after a day or two, I got used to it and it didn't wake me. So I got the parrot. And now when I go to bed I set the alarm clock and put the parrot's cage on top of it. What that bird says when the alarm clock goes off would wake up anybody."

Detective Dad

Man to small boy dragging top half of bikini bathing suit along the beach: "Now, show Daddy exactly where you found it."

Wrong Way

A fellow who had had "just two" drinks with the boys, was driving the wrong way, against traffic, on a one-way street.

Of course a cop stopped him. "Where do yuh think you're goin'?" he growled.

"I dunno," answered the fellow, "but I must be late. Everybody's coming back!"

Texas Style

Boasted the Texas cattleman to the visitor: "We don't brand them. We have them engraved."

Country Folk

A tourist driving along through the country noticed a farmer and his little daughter sitting under a tree. The tourist pulled up alongside and admired the little girl.

"What is her name?" the tourist asked.

"Amalasyinta," the farmer replied.

"Isn't that a rather long name?" inquired the tourist.

The farmer looked at the tourist with contempt. "Listen, son, we're not city folks—we got time."

Suspicion

The boarding house mistress glanced grimly down the table as she announced: "We have a delicious rabbit pie for dinner."

The boarders nodded resignedly; all, that is, but one.

He glanced nervously downwards, shifting his feet. One foot struck something soft, something that said, "Mee-ow."

Up came his head. A relieved smile crossed his face as he gasped, "Thank goodness!"

Worse Kind!

The infantry patrol was on maneuvers on a hot day in the desert. Time was

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Service *Anywhere Anytime*

New Services • • • New Tools • • • New Methods • • • Outstanding Results

Radiation Logger Gives Accurate Detail in 98% Saturated Brine Fluid

This was a multiple well logging project in brine wells in a Michigan field. All operations were performed above 2000'. Wells were cased with 3" O.D. pipe inside of 6" O.D. casing. Fluid was 98% saturated brine solution.

The 14 wells in this particular project were logged with 1¾" O.D. McCullough Radiation Well Logging instruments, averaging 1½ hours working time per well.

Because of the heavily saturated brine solution, other types of logging instruments had not been able to provide required information. All McCullough logs were sharp, clear and detailed. Location of casing collars and bottom of pipe, information that had not been obtainable before, was clearly indicated.

McCullough

Radiation Well Logger

Have you received your copy of this new bulletin? Write to McCullough Tool Company, 5820 South Alameda Street, Los Angeles 58, California. We will send your copy by return mail.

The jobs described above are certified to be true field reports of services rendered.

Scintillation Counter Picks Thin Zones for 960 B/D

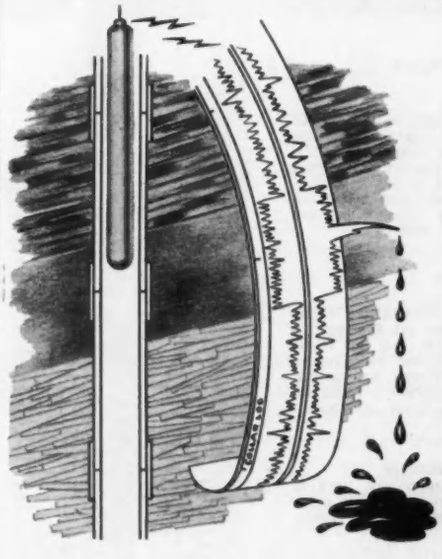
Accurate Down-Hole Information, Provided by McCullough Gamma Ray & Neutron Logs, Assured Pin-Point Perforating of Three 4' Zones For a Fine Producer.

Total depth of this Kansas oilwell was 3648'. 5½" O.D. 14 lb. casing had been set to bottom and cemented.

McCullough's Radiation Well Logger obtained Gamma Ray and Neutron Curves and a simultaneous collar log. Logging information was correlated with the operator's drilling log and three four-foot zones were picked as possibly productive.

The three zones were perforated, one at a time, by 3¾" O.D. McCullough Standard Casing Glass Jets in Steel Strip Carriers. A total of 52 shots were fired.

The lower zone proved to be water bearing and a bridge plug was set above the perforations, sealing off the zone. Upper zones were productive and made approximately seven barrels of oil per hour.



Exact measurement and definition of any potentially productive interval, thick or thin, assures "putting the shots where they count" for greater production—more oil!

Well was then acidized and on test made 40 barrels per hour, or 960 barrels of oil per day. This was the best well in the field.

McCullough's Radiation Well Logger is the most reliable logging instrument available. It has greater stability, provides more detail and assures more accurate quantitative interpretation. The efficiency of the McCullough Scintillation Counter makes it possible to log thin zones with clarity and accuracy.

The simultaneous recording of a collar log means placing the perforations exactly where they are wanted—fully covering the productive formation. And, as in the above case, this means "best possible production"—the best well in the field.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

LOS ANGELES
HOUSTON
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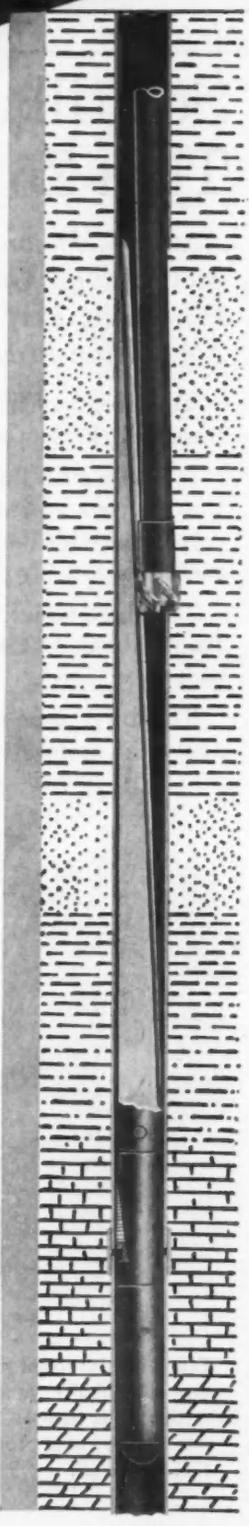
NEW KINZBACH SPEEDMILLS *Slash* DOWN-HOLE CUTTING TIME



UTILIZING TUNGSTEN CARBIDE PARTICLES that continuously renew their cutting edges, new Kinzbach Speedmills offer you faster, surer milling under even rugged down-hole conditions. Because of their extreme hardness, they require fewer replacements . . . fewer round trips.

Kinzbach Speedmills require less torque for cutting . . . eliminate drill pipe wind-up . . . reduce shock on drilling string. They retain their high strength and hardness at elevated temperatures and are unaffected by heat generated by cutting action. Most important, the close control of speed and weight necessary in ordinary subsurface milling operations is not necessary with Kinzbach Speedmills.

For faster cutting . . . surer cutting, be sure your next milling job is done with Kinzbach Speedmills. Types available for every down-hole cutting problem.

Type 154 Speedmill

TYPE 154 SPEEDMILL
This mill is designed for attachment directly to a Kinzbach Type H Whipstock as the first tool in progressive milling operations. After the Whipstock is set, the attachment bolt is sheared and milling operations can begin. The lug on the face of the Whipstock engages the tapered pilot of this mill, forcing it to cut through the pipe wall without thinning the top section of the Whipstock. The Model 154 Speedmill is used to cut the first two and one-half feet of window only.

Type 155 Speedmill

TYPE 155 SPEEDMILL
After the first stage of window cutting is completed, the Kinzbach Model 155 Speedmill is run to complete the window. This tool is designed to utilize cutting force reactions so that maximum length of window may be cut, while side blades are designed to resist reduction in gage diameter during operation.

TYPES 156 AND 159 SPEEDMILLS
For general and milling operations. Used to mill up pipe or tools in the well and to shape the ends of obstructing materials for subsequent fishing operation.

Type 159 Speedmill

Type 156 Speedmill

KINZBACH TOOL CO INC

Export Office:
74 Trinity Pl.
New York, N. Y.

KINZBACH TOOL CO., INC., P. O. BOX 277, HOUSTON, TEXAS

WORLD OIL

"I know the oil industry like the palm of his hand."

called for a break. One recruit sat idly on a stone, his head in his hands.

"What's the matter with him," asked the sergeant.

"Homesickness," answered a private.

"We've all got that."

"Yes, but this is worse than for most of us—his father owns a tavern."

Compromise

The movie bit player demanded sixty dollars a day to play the part of an Indian in a big DeMille epic. "The most I can get you is thirty dollars," said his agent.

"O.K.," he acquiesced, "I'll play a half-breed."

Good Ole USA

Moscow radio says U. S. A.'s a hysterical, topsy-turvy country where people eat upside-down cake, doors go around in circles and everybody has an inside outhouse.

Needless to Pray

"Do you say prayers before eating?" the minister asked the little boy.

"No, sir, I don't need to," replied the child. "My mother's a good cook."

Nothing to It!

A tough, war-weary corporal from Texas rolled a cigaret, stuck it between his lips, leaned his head back, and raised upward until his lips—and the cigaret—barely cleared the top of the foxhole. Whizz! Bang! And a North Korean sniper's gun had lighted the cigaret.

"Never fails," he drawled as he took a

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
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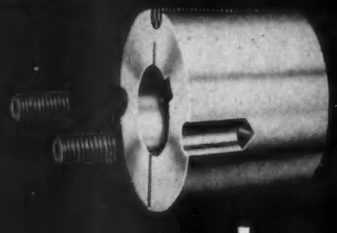
Phone 3-2167

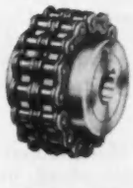
IT'S **TAPER-LOCK**

–IT'S INTERCHANGEABLE!



TAPER-LOCK SHEAVES

TAPER-LOCK SPROCKETS



TAPER-LOCK COUPLINGS
Rigid—Flexible—Chain

TAPER-LOCK STEEL CONVEYOR PULLEYS

The New Way to Cut Costs

Save time in mounting. Cut down-time on production machines. Standardize with Taper-Lock, the *interchangeable* bushing. The same Taper-Lock bushing fits sheaves, sprockets, couplings, conveyor pulleys. That means smaller inventories of power transmission parts. And it means quicker changes when necessary to keep production lines running!

Taper-Lock bushings are available in a range of sizes which makes it easy to change from one size shaft to another. Taper-Lock products slip onto the shaft quickly — hold with the firmness of a shrunk-on fit—come off easily, without shock to bearings or machinery. You'll profit by standardizing on Taper-Lock.

DODGE MANUFACTURING CORPORATION
6500 Union Street **Mishawaka, Indiana**

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new methods. Look for his name under "Power Transmission Machinery" in the yellow pages of your classified telephone directory — or write us.

For more data on advertised products, use Readers' Service Cards, last page.

Anvil Brand Couplings start clean, run up fast because threads and chamfers are precision machined, gaged throughout manufacture, and electro-galvanized. Uniform wall thickness and properly aligned sealing surfaces provide dependable mechanical strength and full joints for trouble-free string service, minimum maintenance.

Anvil Brand Fittings—A.P.I. Couplings for all oil field applications, bushings, plugs, and nipples, are sold through your nearest supply store. Engineering service is always available from Anvil Brand Representatives in key oil country locations. Write for information.

FREE!

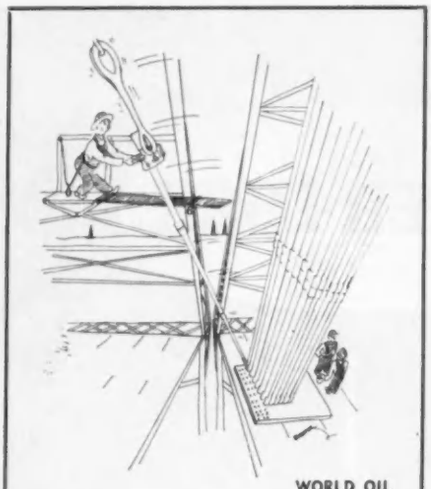
POCKET SIZE THREAD GAGE

Identifies threads from 8 to 14 per inch, round or sharp, external or internal. Only 6¼" long. Write Oil Field Dept., Pittsburgh Pipe and Coupling Co., Allison Park, Pa.

ANVIL BRAND
forged seamless and wrought steel pipe fittings

PITTSBURGH
PIPE and COUPLING COMPANY
ALLISON PARK, PA., U.S.A.

Subsidiary: Anvil Products, Inc., Longview, Tex.
Affiliate: Canadian Coupling and Fittings, Ltd., Simcoe, Ont.



WORLD OIL

"Whadda ya mean, we only got 5200 feet of pipe out of a 7600 foot hole???"

puff. "Do it all the time. Saves matches."

"But, Corp, ain't that dangerous?" asked his buddy.

"Dangerous? asked the Texan in surprise. "Naw, I don't inhale."

Definitions

A lonely man is one who buys himself a necktie the day after Christmas.

She who indulges, bulges.

If women ever get equal rights with men, it will be quite a comedown for them.

A chaperon is one who is too old to get into the game, but not too old to intercept the passes.

If you want to know what is meant by a spitting image, try feeding cereal to a baby.

Like Old Times

The reporters were interviewing the brave girl who had escaped unharmed from the embrace of a huge bear.

"Weren't you afraid when this tremendous animal started hugging you?" she was asked.

"No," she replied, "I once went steady with a wrestler."

No Sweet Rose

"You're a failure!" nagged the wife. "When you courted me you said I should always be the flower of your life, and now—"

"You're still the flower," said the henpecked one, "But no rose—I should say 'snapdragon'."

Ardorless

A GI returned to camp exhausted after a weekend of wine, women and song. On the bunk that held his recumbent form, his buddies hung a sign, "Temporarily Out of Ardor."

Too Much Family

When the unmarried maid of a childless couple informed them she was about to have a baby, arrangements were made for adoption and the maid agreed to stay on in the household. In about a year the same thing happened, and again the couple agreed to adopt the child if the maid would stay.

So the foster parents were surprised when the maid announced she was about to leave and take another job.

"What's the matter, Mary, haven't we treated you right?"

"Oh, yes, you sure have treated me fine," said the maid, "but there's getting to be too many children in this family."

Homeowner's Rights

Driving in a dense fog, a motorist followed the tail light ahead for a full hour, free from worry. Suddenly the red beacon ahead stopped, and the two cars collided.

"Hey, why don't you put out your hand when you're going to stop?" yelled the man behind.

Came the casual reply: "Why should I? I'm in my own garage!"

Censored

A minister, making a call, was sitting with his hostess in the parlor when a small boy rushed in carrying a dead rat.

"Don't worry, Ma, it's dead. We bashed him and beat him until . . ."

And, noticing the minister for the first time, the moppet added in a muted voice, "until God called him home."

All Those Sins?

"Sister Margie," said the parson impressively, as he led her into the brook for baptism, "I'se g'wine lead you out inter dis heah stream, an' wash out every spot o' sin you's got."

"Lawsy, Pahson," giggled the erst-while frolicsome damsel, "in that li'l ole shallow creek?"

Sympathizer

A West Texan pulled up in front of Houston's Shamrock Hotel in a cruiser-length car. He fished a ten-dollar bill out of his pocket and handed it to the doorman.

"Take good care of the car," he said patronizingly.

"I sure will, boss," answered the doorman, "I own one just like it."

Cause of Death?

"This is the skull of a man who was shipwrecked for two years on a desert island with five chorus girls."

"How did he die?"

Nice Site

"Why did you park here when there are nicer places farther on?"

"Love at first site."

Reverence

A quick-thinking employe came up with a new one when his foreman said, "Hey, bud, how come you're sleeping on the job?"

"Goodness gracious," he shot back, "can't a man close his eyes for a minute of prayer?"

HYDROCARBON
WELL LOGGING

Domestic
and
Foreign

CARAN
ENGINEERING
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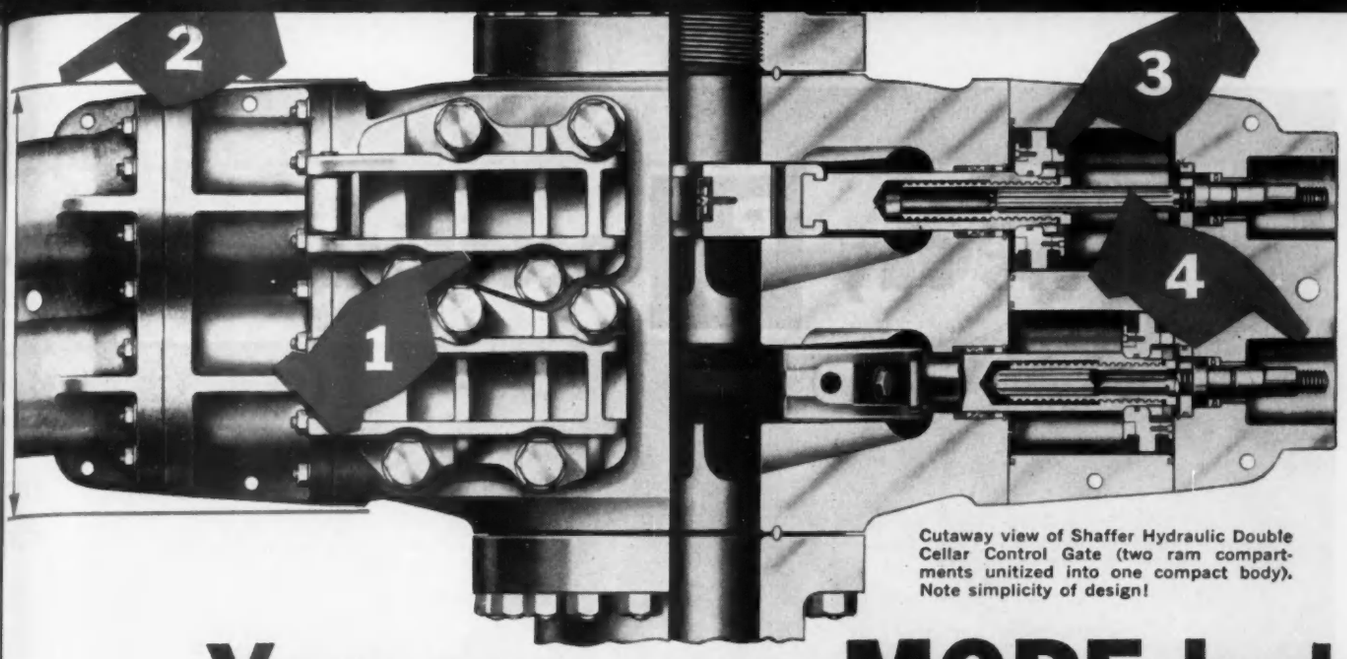


Cutaway view of Shaffer Hydraulic Double Cellar Control Gate (two ram compartments unitized into one compact body). Note simplicity of design!

You can pay MORE but you can't buy BETTER than SHAFFER Cellar Control Gates

Before you buy your next cellar control gate equipment, check the field. Note the unique **years-ahead** *features built into Shaffer Hydraulic Gates. Compare—and you'll find you can pay* **more** *for cellar control gates, but you can't buy better than Shaffer!*

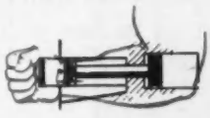
ADVANTAGE #1

Simply open convenient side doors to change rams—and closing the doors automatically aligns the new rams for proper operation. No extra room is needed above the gate—nor is added space required at the ends—to change rams. Moreover, complete ram changes can be made whether the pipe is in or out of the hole!

ADVANTAGE #2

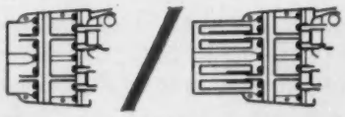
Shaffer Gates are not only compact in all three dimensions—length, width and height—but there's no need to expand the gates endwise to change rams, nor need extra space be allowed above the gates for lifting out the rams. Even sizes as large as 13⅝" (12" Series 900) are only 18½" high in Single Gates—only 30" high in Double Gates!

ADVANTAGE #3



In Shaffer Gates there are no complicated yokes, no secondary connections between pistons and rams. For maximum safety and simplicity, each ram is operated by a single direct-connected piston!

ADVANTAGE #4



Whether you prefer the extra compactness of a non-rising locking shaft, or the quick indication of ram position afforded by a rising shaft, you choose the design you prefer when you select Shaffer Gates!

In addition, Shaffer Gates have *Self-Draining Compartment Bottoms* (no detrimental sand or mud accumulates to interfere with free ram travel)... *Completely Enclosed Design* (no exposed moving parts to become damaged or corroded)... *Built-In Flow Connections,* and many other unsurpassed features that add up to greater safety, greater dependability, greater convenience. Get the full story from your nearest Shaffer representative—or write direct for further details!

FREE! Send for your copy of the complete Shaffer Catalog.

See the Shaffer section of your latest Composite Catalog.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
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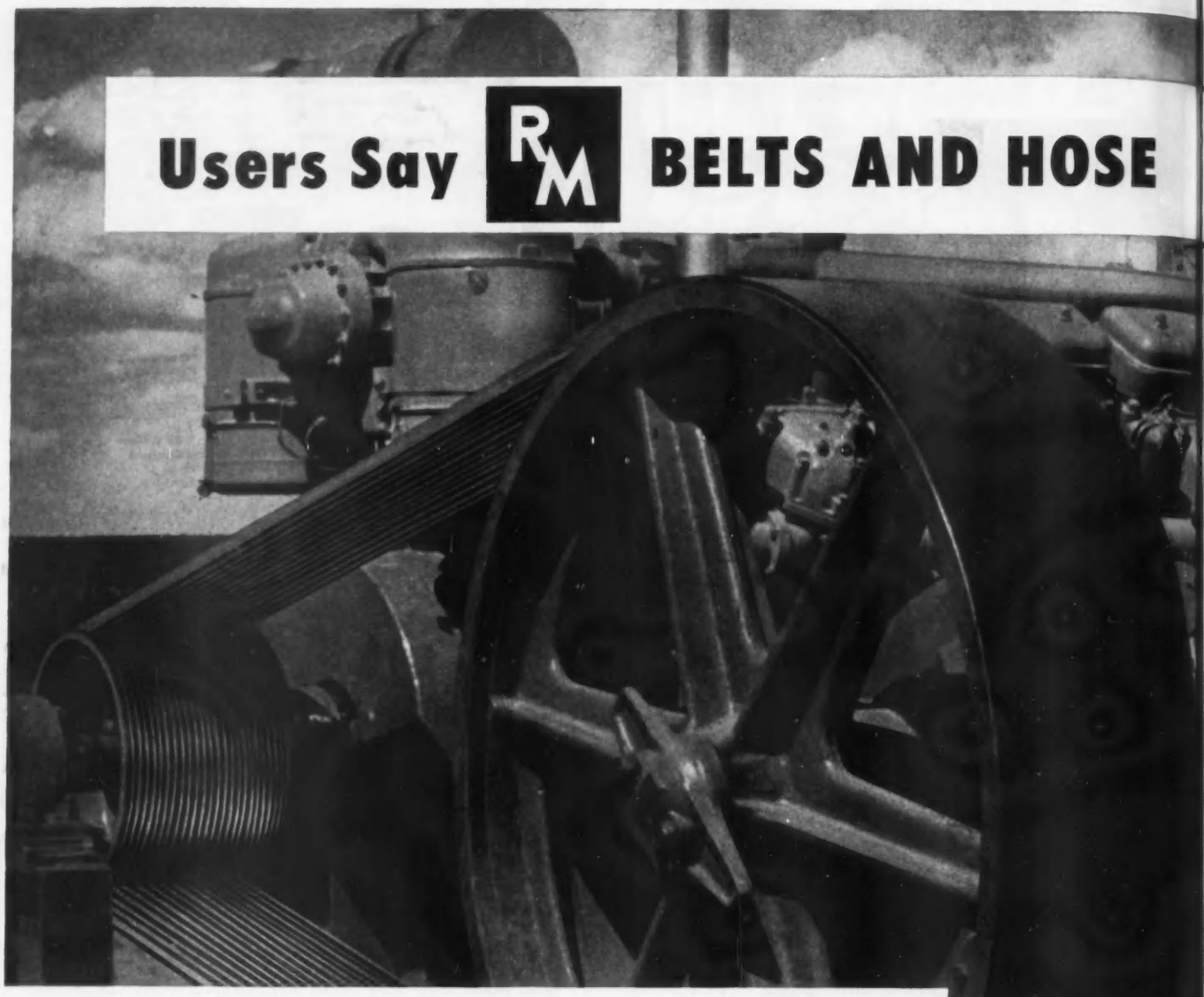
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U. S. A.

34 years OF OIL TOOL LEADERSHIP

Users Say R/M BELTS AND HOSE



R/M *Poly-V*® Drive Puts New Push in Deep Hole Drilling!

No other belt can deliver as much power in as little space as R/M Poly-V. A *single, endless* V-ribbed belt runs on sheaves specially designed to mate precisely with the belt ribs. Uniform pull of the single unit belt gives higher horsepower capacity per inch of drive width than ever before possible. This patented new concept in heavy-duty power transmission delivers up to 50% more power in the *same* space as ordinary V-belt drives . . . *equal* power in as little as ⅔ the space!

The patented R/M Poly-V Drive meets the needs of today's deeper drilling operations . . . puts that extra power push behind a slush pump, to permit more rapid circulation of mud, faster drilling speeds and longer drill bit life. Eliminates the problem of matching multiple V-belts in the field and greatly increases the working life of both belts and sheaves. Just *two* cross sections of R/M Poly-V meet *every* power requirement — field inventories are reduced to a minimum!

Write for Bulletin #6638

*Poly-V is a registered Raybestos-Manhattan trademark.

. . . And For "The Smoothest Running V-Belts Made," Specify CONDOR and R/M SUPER-POWER V-BELTS

Give You "More Use per Dollar"

Ray-Man Rotary Hose Handles Easiest on the Rig

. . . and *safest*, too. R/M's method of applying high tensile steel cable wires under precisioned tension makes Ray-Man CBL Rotary Hose unequalled for strength, flexibility and safety. It holds steady in the derrick without whipping . . . even under the high-pressures of deep drilling. And when it comes to moving from location to location Ray-Man's flexibility and light weight minimizes the dangers of accidental crushing and kinking in transport . . . assures easier, faster rigging up on the next job.

Ray-Man's streamlined, built-in coupling adds to your safety on the job, too. Designed without protruding lugs or flanges that cause fouling, it features R/M's special leak-proof "Lip-Lok" seal that actually tightens under pressure to prevent dangerous — and costly — blow-outs!

Add Manhattan's oil-proof tube for drilling-in with oil or oil-base and you've got easier, safer handling and longer, trouble-free services at less cost on *every* drilling job . . . with Ray-Man CBL Rotary Hose.

Write for Bulletin #6743 for details

There's an R/M Hose For Every Oil Field Use!

You'll find "More Use per Dollar" features in these R/M hose constructions, developed especially for oil field service:

Manhattan Mud Pump Intake Hose — designed with Type 'C' Leakless Built-In Nipples for rough service with the most powerful mud pumps.

Manhattan Geophysical Hose — dependable strength, longer service in drilling small test wells.

Ray-Man Rotary Vibration Hose — to withstand high pressures between mud pump and rig standpipe.

Discuss your hose needs with an R/M representative.

RM 721

BELTS • HOSE • ROLL COVERING • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

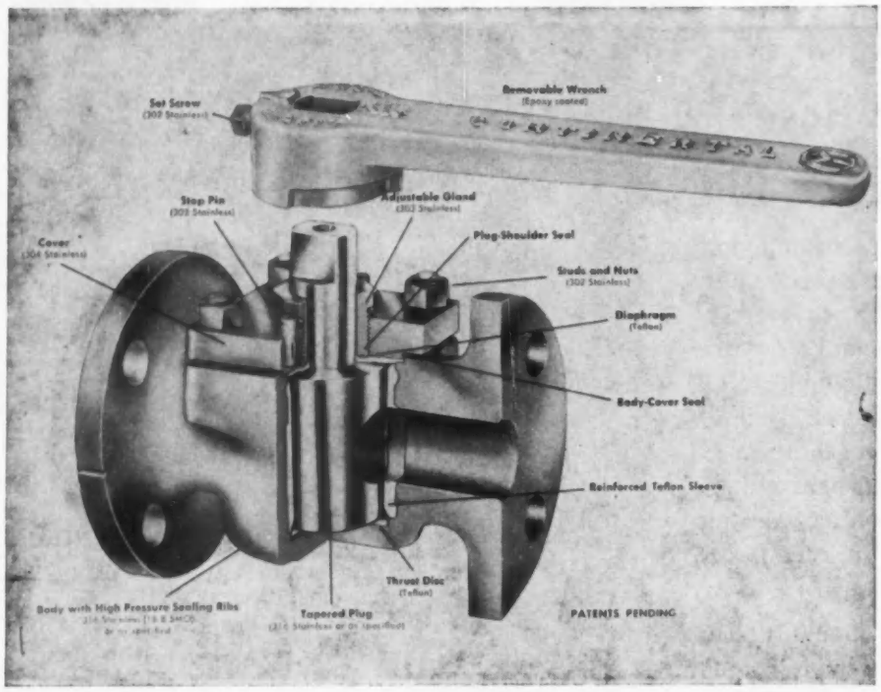
MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

What's New In Equipment

Drilling • Production • Exploration



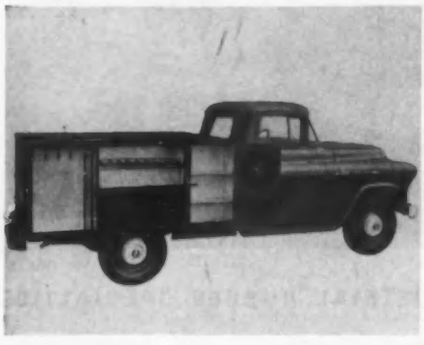
Rugged Plug Valves

A line of stainless steel plug valves, trade named Tufline, has been introduced by the Continental Manufacturing Co. The new units are compact and ruggedly designed, have Teflon sleeves which eliminate need for any lubrication. An unusual design feature is the internal ribbed construction which locks the sleeve in position for high-pressure continuous sealing around body ports and bore, yet permits sleeve expansion and contraction without leakage.

The low-friction Teflon sleeve permits free turning of the plug under all operating conditions, and plug rotation is limited to one-quarter turn by stops in the valve cover. Fully enclosed metal construction, shield-type epoxy-coated wrench, no exposed Teflon, and four-bolted cover give maximum protection against fire or line shock. Absence of any lubrication prevents stream contamination, and sleeve wiping action keeps the plug free of adhering solids or liquids.

Recommended for liquid and gaseous corrosives; solvent and slurry services; or for hydraulic and pneumatic services where standard valves will not seat owing to mechanical interference from entrained solids, polymerization, crystalline deposits or heavy slurries.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.



New Construction Body

The Utility Body Company of Oakland, Calif., has recently added a new model to their extensive line of service and construction bodies, known as Model UB.

This service body is low in cost yet incorporates many special features of bodies selling at considerably higher prices. Among the special features of Model UB are roomy 15-inch compartments with shelves and trays to hold tools and a full four-foot wide bed with a die-formed, anti-buckling, heavy-duty plate floor for added strength and less dead weight.

Hinged to the body on special free-moving bearings are double panel doors. Flush, pull-out type door handles with slam-action catches and master-keyed cylinder locks are used throughout. Rolled edges on all parts are a safety feature. The all-steel, electrically welded body is built to outlast any truck chassis. Exterior surface is acid-etched to clean and protect the metal, then primed with a non-flaking primer to prevent rust. The entire underside is covered with underseal at no extra charge.

Optional equipment includes side or overhead ladder racks; telescopic steel cover with end-gate enclosure to close off bed; removable pipe vise bracket with front support; and rear bumper with safety-tread step and pipe carrier with tension clamps. At the buyer's option, any service body will be painted and installed, or prime coated and crated for shipment.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Petron Seismic Explosive

Atlas Powder Company announces the completion of its line of seismic explosives with the availability of Petron, a canned blasting agent specially designed for seismic prospecting. Known as a blasting agent rather than a high explosive because of its relative insensitivity, Petron can be detonated only by a suitable priming charge. Neither blasting caps, detonating fuse, flame, nor impact will detonate Petron itself.

Cans of Petron are designed for fast screw assembly into rigid columns which, when properly prepared, will withstand much more loading pole pressure than gelatin charges. The blasting agent can often be loaded into holes which will not accept gelatin charges and, in many cases, drill hole casings, required by gelatin, are not needed when using Petron.

Petron is available in one pound cans of 2-inch and 2½-inch diameters. Both sizes are shipped in 50-lb. cartons. In the cartons, the cans are already assembled in short columns, to facilitate assembly of longer columns in the field.

Special Petron Primers are available in the same weights and dimensions, but are shipped as single units in 50-lb. cartons. Primer Shields, for the assembly of Petron Primers, and Points to facilitate loading of the column are also available in both 2- and 2½-inch diameters.

Petron is said to be extremely water resistant and therefore ideal for preloaded holes.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

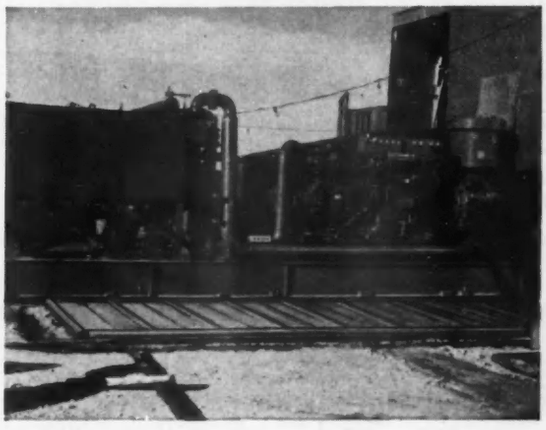
NOW all the air you need for drilling from one compressor

When you need air for aerated mud drilling why use a dozen compressors when one will do the job! The Air-Pac packaged air compressor has proved highly successful in field service.

The Air-Pac is a completely automatic 500 horsepower compressor, belt-driven off the rig's compound. The Air-Pac will automatically maintain any desired discharge pressure between 500 and 1500 psi. An automatic controller also holds the input horsepower steady over the complete range of pressures to eliminate engine stalling. The balanced/opposed design of the compressor means you don't have to fuss with it when you install it. Set it on timbers . . . it won't "walk" away. There is nothing intermittent about the Air-Pac either . . . use it for one or 5000 hours.

Low pressure units are also available for air drilling, incorporating all the features of the high pressure aerated mud unit. For a packaged air compressor that's just as rugged as the rest of your rig . . . be sure you look into the Clark Air-Pac.

"On the job." Notice that AIR-PAC is not bolted down. Strut rods to rig maintain belt tension.



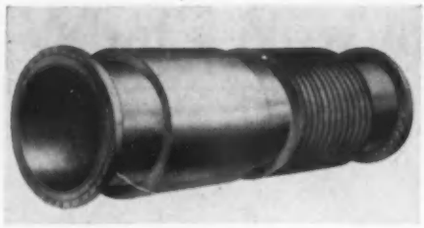
CLARK BROS. CO. **OLEAN, NEW YORK**

One of the Dresser Industries

Offices in Principal Cities Throughout the World

CLARK **Air Drilling Compressors**

For more data on advertised products, use Readers' Service Cards, last page.



Service-Rated Joints

Badger Manufacturing Company is offering an entirely redesigned line of packless corrugated expansion joints for use in power, heating, industrial and process piping applications.

The new Badger service-rated expansion joints are available in several types which are classified in series according to the pressure-temperature conditions to be encountered in much the same way that pipe flanges are rated by the ASA. Thus, joints in Series 50 are for lower line pressures while joints in Series 150 and higher are for higher pressures.

Badger service-rated joints of Series 150 and higher also have the improved corrugation shape found in Series 50 joints. However, because these joints are designed for use where there are higher line pressures, they also have reinforcing rings. The design and functioning of these rings is probably the most significant improvement in expansion joint engineering made up to this time.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

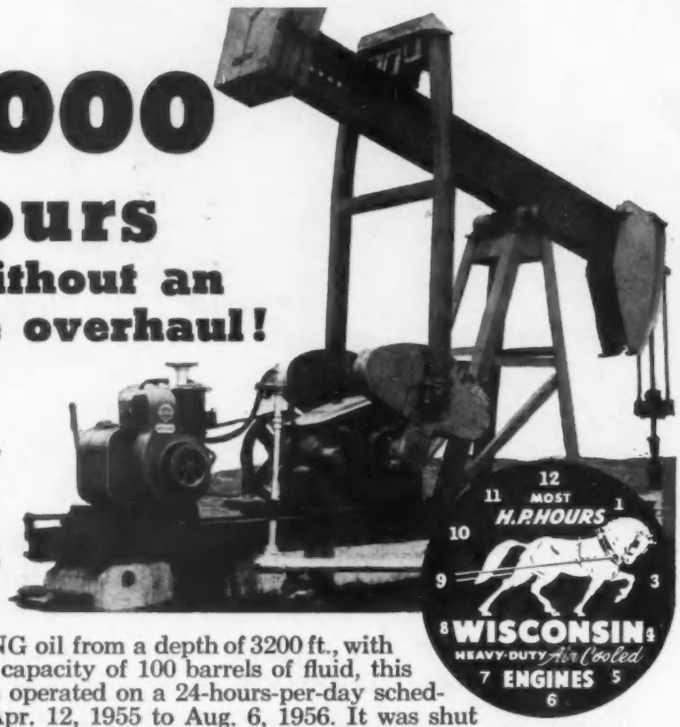
Newco Pipe Hook

The Newco Manufacturing Company has designed a new potential pipe hook for the handling of thin wall beveled edge oil or gas pipe. The new pipe hook has 1-inch throat opening and a wide flange lip to give more bearing surface.

A soft brass insert has been placed in the neck so that no damage can be done to the beveled edge. This new hook is a steel casting with 79,000 tensile, weight 8½ pounds, and has a rated safe working load of 8500 pounds.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

11,000 hours without an engine overhaul!



● This Model TFPD Wisconsin Air-Cooled Oil Well Pumping Engine was operated practically continuously for a total of 11,000 hours (the equivalent of approx. 75,240 hp. hours, operating at 1800 rpm., 60% loaded) . . . verified by the sworn statement of the supervising oil field foreman.

PUMPING oil from a depth of 3200 ft., with a daily capacity of 100 barrels of fluid, this engine was operated on a 24-hours-per-day schedule from Apr. 12, 1955 to Aug. 6, 1956. It was shut down only for such ordinary maintenance as changing lubricating oil, spark plugs and magneto points.

When this engine was brought to the shop for inspection and possible repairs, after its grueling 11,000-hour oil well pumping assignment, the shop mechanics were surprised to find the valves in excellent condition, needing only slight grinding. Piston pins were not worn enough to need changing and cylinder walls were still in condition to permit the use of standard rings. Even the connecting rods showed practically no wear. After minor repairs the engine was put back on the job, pumping the same well, and is still going strong!

Here is tangible proof of Wisconsin Engine heavy-duty stamina and basic *High Quality* design and construction in all details . . . including such features as tapered roller main bearings, Stellite exhaust valves and valve seat inserts, in combination with positive type valve rotators, and many other outstanding service advantages.

You can't do better than to specify "Wisconsin Power" for your equipment.

Model TFPD Wisconsin Oil Well Pumping Engine

Get the details about this 2-cylinder Wisconsin Heavy-Duty Air-Cooled Oil Well Pumping Engine, with built-in HIGH MOMENTUM FACTOR.

WISCONSIN MOTOR
Corporation
MILWAUKEE 46 WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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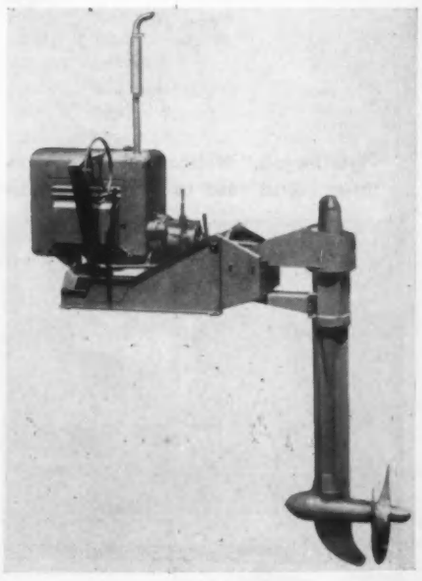
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

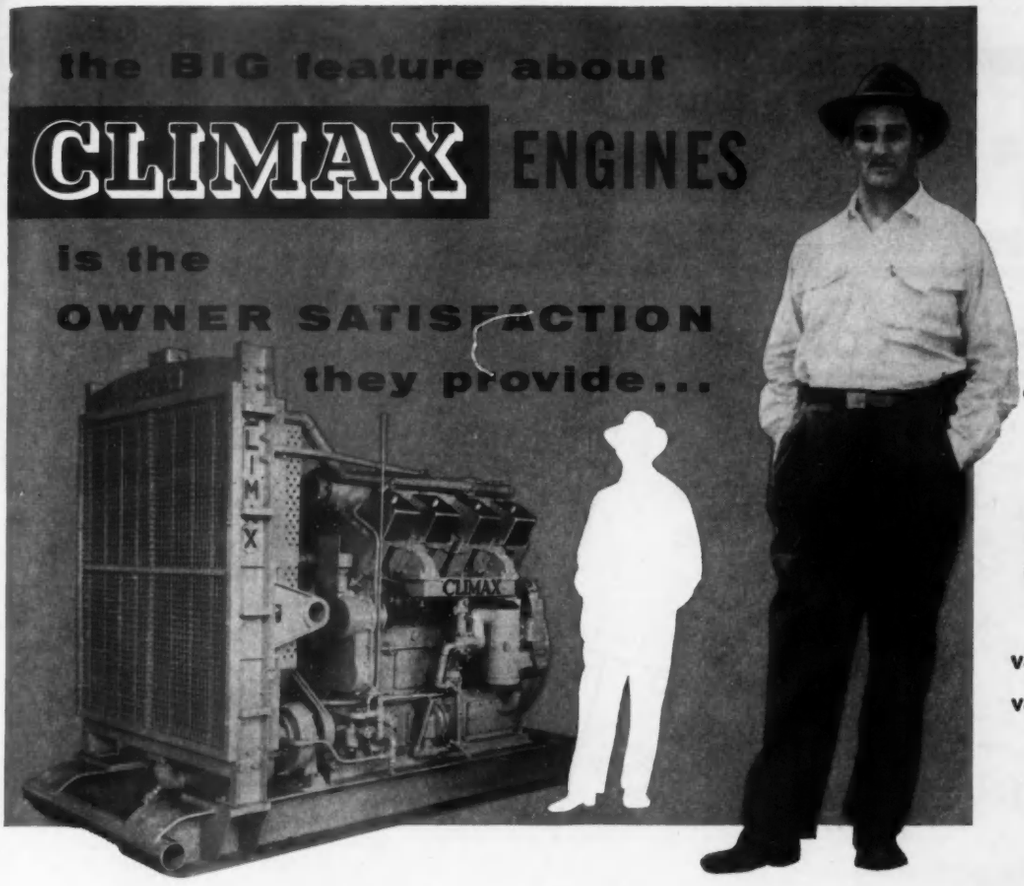
A7-6071-½-I



Harbormaster Utility Series

New Utility Series Harbormaster outboard propulsion and steering units, offering practically all the advantages of standard Harbormasters at considerably lower cost, are announced by Murray & Tregurtha, Inc., Quincy, Mass.

Harbormasters are complete, heavy-duty marine power and steering units, providing many features not found with ordinary marine power. They are easily installed on new or existing craft such as barges, towboats, work boats, etc., and



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—an engine backed by prompt service throughout the oil country . . . friendly Climax Distributors offering a complete stock of parts, repair facilities and factory trained mechanics.

—these, plus many other Climax advantages, add up to owner satisfaction . . . the kind you get when you buy Climax Engines!

See, call or write your nearby Climax Distributor today!

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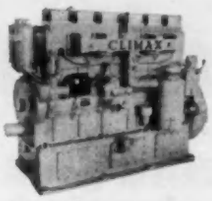
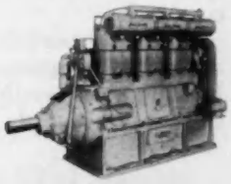
V-122—12 cylinder, 520 max. hp. at 1200 rpm.
V-125—12 cylinder, 610 max. hp. at 1200 rpm.

V-80—8 cylinder, 340 max. hp. at 1200 rpm.
V-85—8 cylinder, 390 max. hp. at 1200 rpm.



K-67—6 cylinder, 265 max. hp. at 1200 rpm.
K-75—6 cylinder, 305 max. hp. at 1200 rpm.



R-165—6 cylinder, 194 max. hp. at 1200 rpm.

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A NEW IVERSON SUPPLY STORE

For the FOUR CORNERS AREA

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Iverson Supply Company announces a new store to serve the four corners area of Colorado, New Mexico, Utah and Arizona.

The new store, located at Cortez, Colorado is completely equipped to serve customers round-the-clock, with both the speed and efficiency long known to Iverson Supply Store customers.

In rush periods, the Cortez store will be able to draw additional supplies from the nearby Iverson Supply Store in Farmington, New Mexico . . . a *plus service* available only from the Iverson Supply Company!

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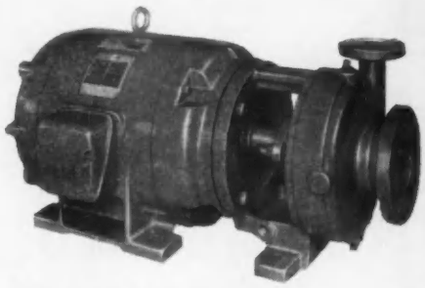
they are efficient and economical to operate and maintain.

Available in 40 horsepower and 60 hp gas or Diesel models, the new Utility series Harbormasters provide the same heavy-duty performance and high thrust per horsepower as comparable standard models.

For more data, circle **No. E6** on Readers' Service Card, last page this issue.



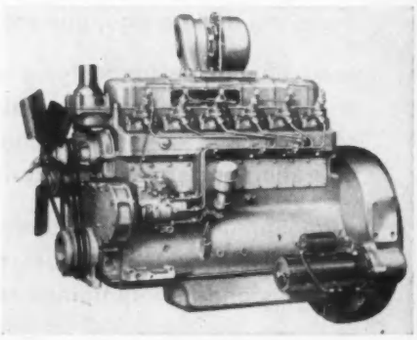
Space-Saving Pump

For the pump user who wants to conserve on both space and investment, Dean Brothers Pumps Inc., Indianapolis, Indiana, offers a new line of standard, close coupled, centrifugal pumps designed to handle a wide range of general applications where conditions do not necessarily require a more costly engineered pump.

Identified as Type GSC, the line comprises seven pumps with capacity up to 60 gallons per minute and total dynamic head up to 275 feet. Temperature range of liquids that can be pumped is from minus 40° F. to plus 250° F.

The line is available from stock in materials of three standard classifications: bronze fitted, all iron and all bronze.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.



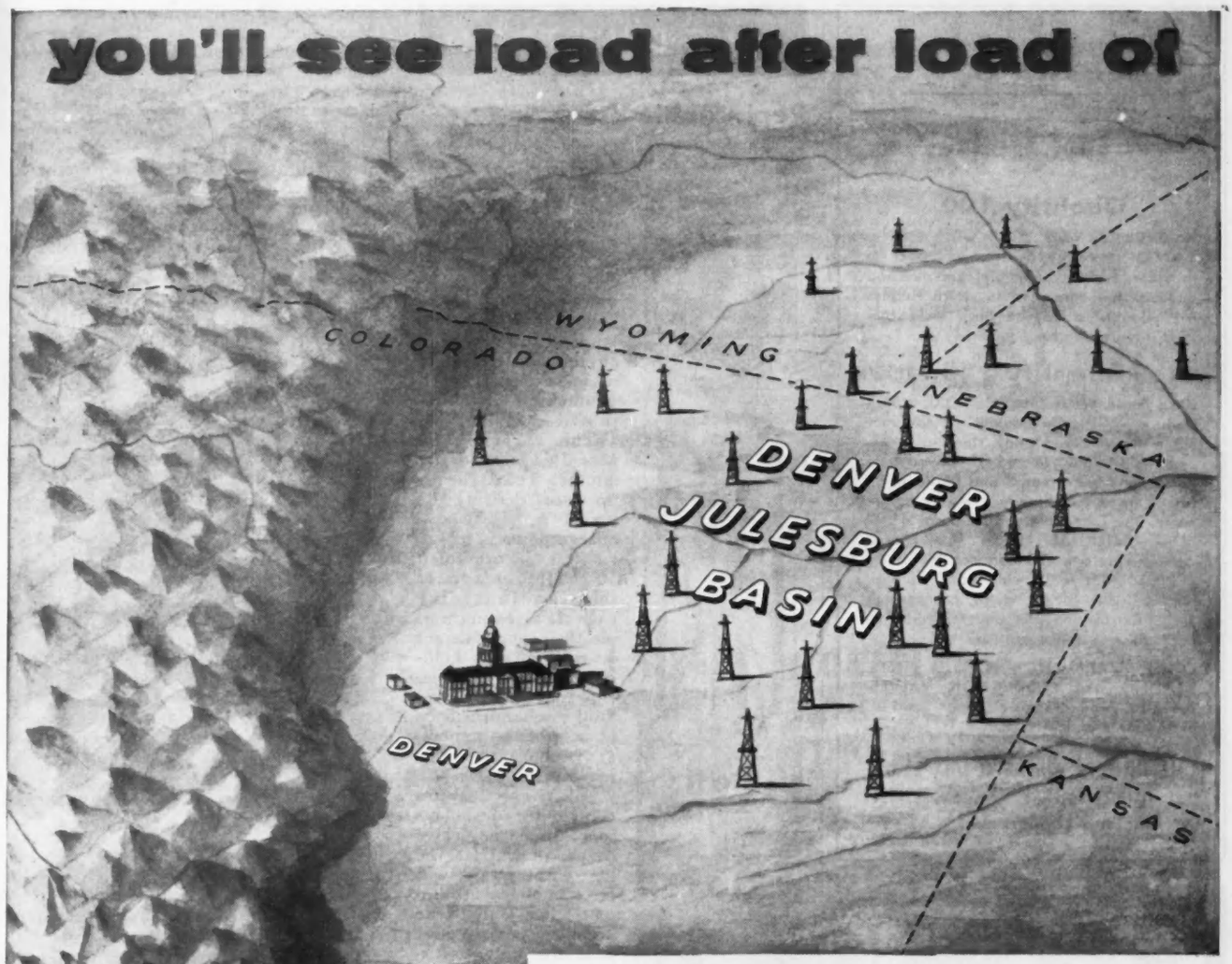
Supercharged Engine

This latest Waukesha supercharged engine model, the 197-DLCS, is a compact, heavy-duty, six-cylinder, four-cycle, full Diesel engine of 302 cubic inch displacement. The patented combustion chambers burn all standard high-speed Diesel fuels having cetane values of 45 or above.

The exhaust turbocharger system of supercharging affords a great increase in horsepower with a minimum of parasite load. Even without an intercooler the maximum power available from the Model 197-DLCS Turbi-Diesel is 131 hp at 2800 revolutions per minute. Without positive drive from the engine, the parasitic load decreases at part engine load, which improves over-all fuel economy throughout the speed range.

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

you'll see load after load of



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in the Denver-Julesburg Basin

There are good reasons for such acceptance. Every foot of CF&I Seamless Casing and Tubing is made under rigid quality controls to assure dependable service. And CF&I's mill at Pueblo, Colorado, is ideally located to give prompt, efficient service even on emergency rush orders. No wonder so many operators in the Denver-Julesburg Basin, and all over the West, depend upon CF&I Oil Country Goods!

Made to API STD 5A specifications, CF&I Seamless Casing and Tubing is available in popular sizes from 2⅜" through 9⅝" O.D.

3693

SEAMLESS TUBULAR PRODUCTS

THE COLORADO FUEL AND IRON CORPORATION
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CF&I

For more data on advertised products, use Readers' Service Cards, last page.

Frustrated Export

Tool Joints

Quantity 100

Hard Faced Wear Subs. 3⅞" O.D. x 1.13/16" bore x 15" long shoulder to shoulder, screwed tool joint pin one end and box the other end to match Hughes 3½" double streamline flash weld tool joint threads. No hard facing.

Quantity 120

Hard Faced Wear Subs. 6¼" O.D. x 3¾" bore x 15" long shoulder to shoulder made from forged alloy steel to S.A.E. 3140 plus 15% to .25% Molybdenum adequately heat treated and finished machined to A.P.I. Standard where applicable. The subs have ends screwed **4½" A.P.I. INTERNAL FLUSH** tool Joint Threads, pin one end and box the other, provided with a 3" wide band of high quality hard facing metal commencing 3½" from pin shoulder and left black as applied i.e. not ground.

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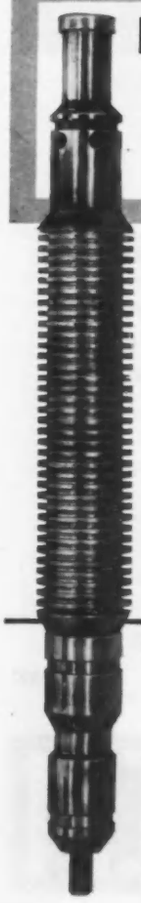

PLUNGER LIFT *where a more effective seal is required*

The HB all-metal plunger seal*, with individually machined washers, shifting from drift to nominal, forms an efficient seal against by-passing gas.

This design allows smaller clearance without the risk of hanging on minor restrictions in the tubing.

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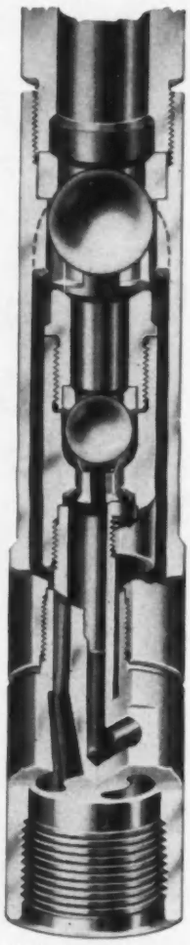
PRODUCTION

Replaceable Valve Cage

The standing valve cage is an individually replaceable unit. It serves also as the housing around the discharge cage. A unique feature here is the use of the bottom of the seat plug on the screw type seat as the standing valve ball stop. This circular stop, with its fluid cushion, effectively dampens out the ball pound and gives improved cage life.

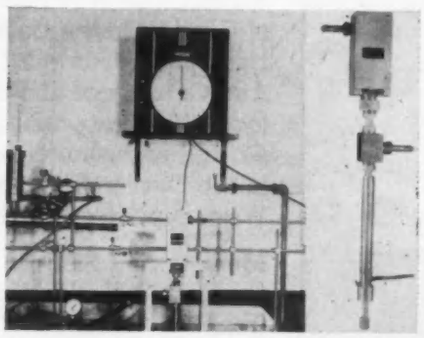


The Oilmaster Model 63 incorporates another feature for operators desiring the lowest possible discharge point. A no-go ring is incorporated at the upper end of the standing valve cage. If a seating nipple 18 inches or longer is run, a cup hold-down less the no-go ring may be used, and fluid discharge will be at a point immediately above the seating nipple.

All these features contribute to a bottom discharge valve that will outlast the life of the pump, will be economical to repair, and will give improved performance over the bottom discharge valve previously offered.

The Model 63 has overcome the existing limitations on bottom discharge valves, and should substantially increase the number of wells where its application is well justified.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.



High-Pressure Flow Meter

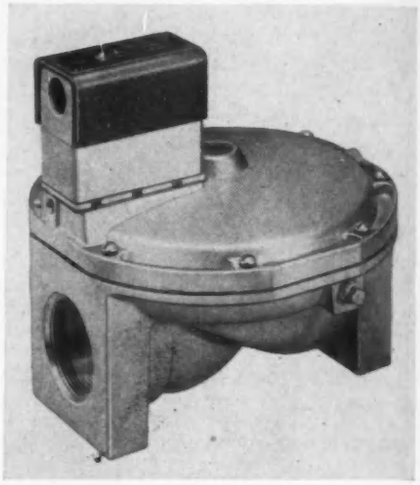
A new high-pressure flow meter, rated at 15,000 pounds per square inch at 100° F., has been designed for the metering control of liquids and gases by C-Mar Corporation.

Three interchangeable stainless steel flow tubes with variable tapered orifices and floats, permit up to 30 desired flow ranges from 0.1 ML (minimum) to 13 liters (Maximum) per minute. All stainless steel, non-magnetic construction; total meter weight, 35 pounds.

Interchangeable jackets can be obtained for jobs calling for meter to be heated while on flow and for working pressures from 50 to 1000 pounds increased flow ranges up to 1000 liters per minute can be obtained on custom order.

The unit is designed for linear reading with Atcotran explosion-proof differential transformer and Atcotran dial indicator (class 6104).

For more data, circle **No. E10** on Readers' Service Card, last page this issue.



New Gas Valve Line

Addition of two new models to its line of relay-operated diaphragm gas valves has been announced by Minneapolis-Honeywell Regulator Company.

The two new valves will become the firm's basic line-voltage models for commercial and industrial burners of five pounds rating. One valve model (V-48F) is furnished with position indicator but without manual opener and is designed for final shut-off service. The other model (V-48G) is a general-purpose type and is available with manual opener but without position indicator.

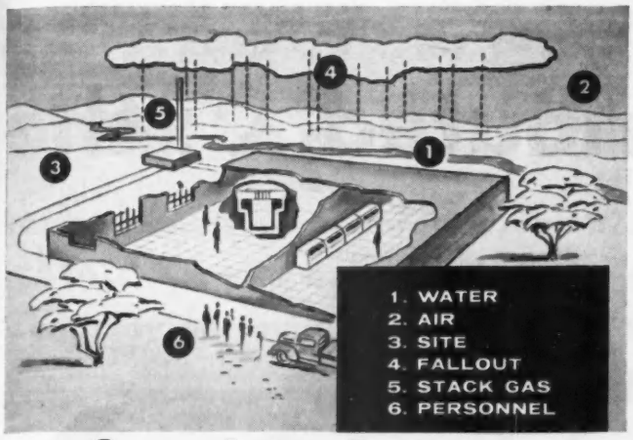
All of the models feature compact design, quiet operation, large valve actuator porting and increased capacity. They are designed for right or left-hand installation and use a weight- and spring-loaded diaphragm for dependable closing. Electrical parts are mounted outside the gas stream and terminals are provided for each electrical connection.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Non-Slipping Meters

A special type three-way valve which eliminates slippage is now standard equipment on Rolocheck meters and Rolocheck metering separators, manufactured by Rolo Manufacturing Company.

The valve, called the Neutral Position 3-Way Valve, has valve discs which move with relation to the valve stem, the discs being separated by spring pressure. By means of this special (three position) construction, the open port closes before the other port opens. On the Rolocheck meter, this insures against the possibility of both valve ports being open at one time, as



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To obtain a license to operate a reactor, it is necessary to obtain meteorological, hydrological, geological, and seismological data for enclosure with your application to the Atomic Energy Commission.

To retain your license, you must retain documentary proof that your facility meets Federal standards for protection against radiation.

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- Radioactivity and elemental analysis of environmental samples.
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For your free copy of the latest health and safety AEC regulations, "Standards for Protection against Radiation (10 CFR part 20)", effective February 28, 1957, write Technical Publication Dept., Tracerlab, 1601 Trapelo Road, Waltham, Mass.

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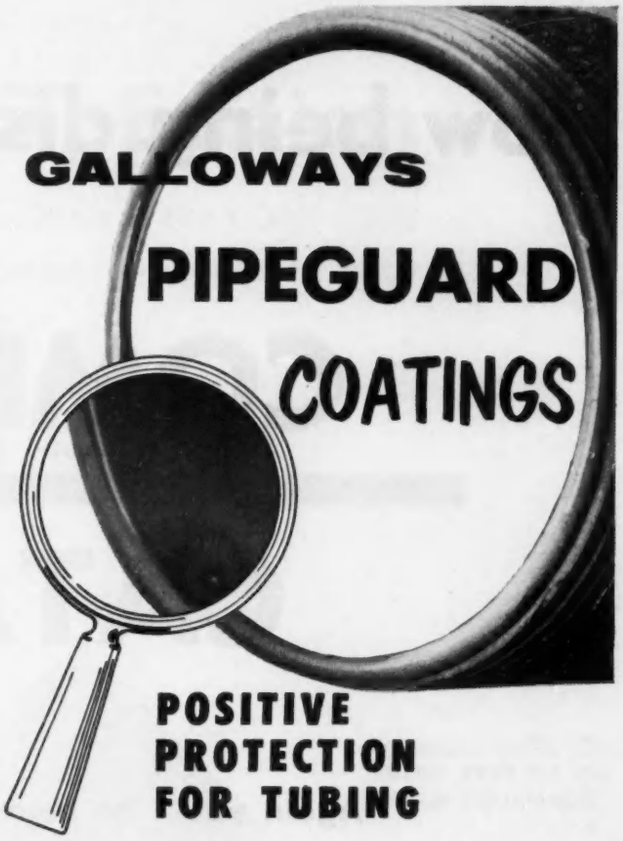

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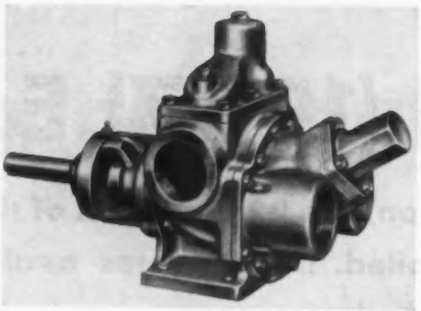
would be the case with other types of 3-way valves during the valve switching operation. Oil cannot bypass the meter with this valve, thus assuring maximum meter accuracy.

(This item supplements Rolo Manufacturing Co. data on Pages 4398-4399 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

Aromatic Pumps

By capitalizing upon the high efficiencies inherent in their universal-joint action for rotary positive displacement pumping, Granberg Corporation has developed a new pump with service characteristics for



pumping dry, aromatic liquids or any other petroleum product.

The new "A" type pump is designed with self-lubricating, friction-free bearings so that no lubricants can contaminate the aromatic liquids. Hardened and ground steel shaft bearings, and steel-sleeved stub shaft bearings are manufactured to withstand years of maintenance-free service. Radial thrust ball bearings and outboard thrust collars protect the pump against power-take-off thrust and pre-loads. Mechanical seals prevent leaking stuffing boxes.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

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NOW 19 MODELS
MODEL RES
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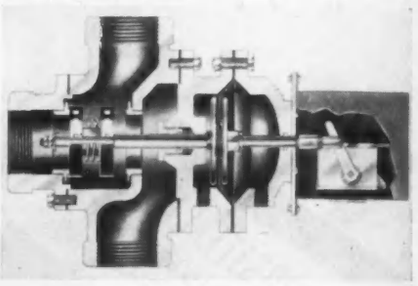

Positive Volume Meter

A new positive volume meter, designed to measure accurately the flow of liquid from well, separator, treater or tank, is now being offered by National Tank Company, Tulsa, Okla. Known as the "PVM," the meter measures the positive volume between closed valves and is not dependent on accurate repetition of level controls, weirs or rate of flow.

The PVM meter is liquid packed, sampled and then counted as the liquid is discharged. An optional and unique feature is the automatic sampling of each cycle which takes out a pencil-thin core and saves it in a separate container so that the exact content of BS&W can be determined later.

(This item supplements National Tank Co. data on Pages 3621-3640 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E14** on Readers' Service Card, last page this issue.

Time-Saving Tubing Head

A Universal tubing head, one which allows an operator to dually complete a well without last minute changes in techniques and equipment even though only a single completion originally was planned, has been engineered and developed by the Oil Center Tool Company.

The new head is adaptable to any completion practice using either single or dual tubing strings. The equipment also permits a last-minute change to a single completion if a proposed dual completion fails to materialize.

These changeovers are possible without changing tubing heads or ordering special adapter spools. Two retractable aligning screws are supplied to orient dual hangers with respect to the head itself. These aligning screws may be retracted when single string hangers are used.

(This item supplements Oil Center Tool Co. data on pages 3741-3776 of Composite Catalog, 21st Edition.)

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

TOUGH FINANCING PROBLEMS?

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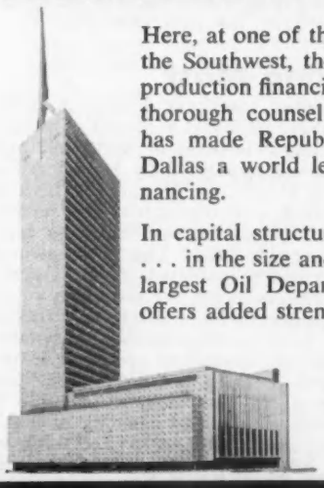

Here, at one of the pioneer oil banks of the Southwest, the toughest problem in production financing receives the expert, thorough counsel and guidance which has made Republic National Bank of Dallas a world leader in petroleum financing.

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A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

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Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

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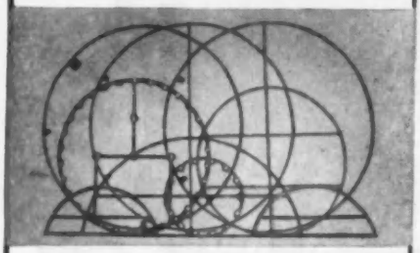

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Composite Catalog, Page 3369

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DRILLING

40 and 50 KG Swivels

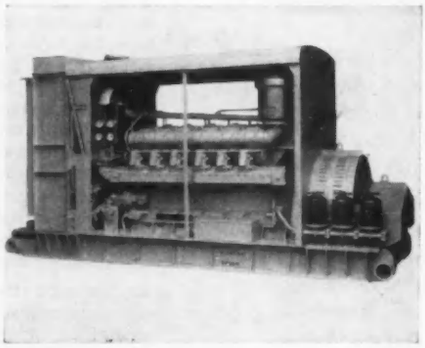
The industry is getting its first look at the new 40 KG and 50 KG swivels by King Oil Tools, Houston. These new swivels will replace King 40XV and 50XV swivels for shallow wells up to 4800 feet. All the best features of the XV's have been retained and several important new features added to produce the new 40 and 50 KG swivels.

The KG series contain a new wash pipe and packing box arrangement which permits a much higher-speed rotation, and the packing can be changed without "breaking - out" Changing the packing is simplified and thread-galling is eliminated.

Other features include: A Zerk fitting to assure easy lubrication of V-type packing; an adjustable stuffing box to insure maximum life of the packing. The complete packing unit can be replaced in the field within a period of ten minutes which results in less shut-down time. Another feature is an oversize watercouse which makes KG swivels ideal for drilling by conventional and reverse circulation methods.

(This item supplements King Oil Tools data on Pages 2784-2787 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E16** on Readers' Service Card, last page this issue.



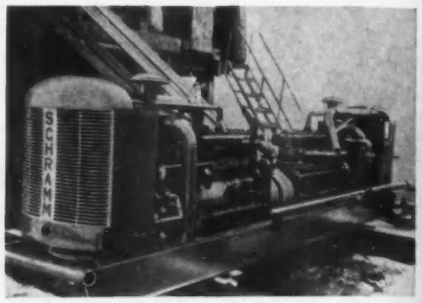
Oil Drilling Unit

Davey, Paxman & Co., Ltd., of Colchester, England, have recently introduced a completely redesigned version of their Package oil well drilling set incorporating the type 12rph Vee form engine. This new set is known as the Drilpak 400 and is one of a comprehensive range of oil field drilling units comprising seven vee engines from 4 to 16 cylinders normally aspirated and 12 and 16 cylinders pressure charged, all of 7-inch bore by 7¾-inch stroke.

The Drilpak 400 has been designed to give the maximum degree of component accessibility with the prime object of reducing maintenance time to the minimum. Dimensionally the oil field type skid base is the same as the earlier Package sets and is therefore fully interchangeable in accordance with oil field standardization requirements.

(This item supplements Davey, Paxman & Co., Ltd., data on Pages 4123-4130 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E17** on Readers' Service Card, last page this issue.



PTO Compressor

The Petroleum Division of Schramm, Inc., has announced a new, 1200 cfm air drilling compressor, which is belt-driven from the rig's compound in the position normally occupied by the mud pump. The unit utilizes the available rig power through 7 V-belts for each compressor, and can be used on a 16-groove sheave on the rig compound with two belts omitted in the center grooves for installing and removing belts. The compressor can also be driven by independent power mounted on a common skid base.

Especially recommended for oil field use, the compressor is ruggedly constructed and moderately priced, according to the manufacturer. Extremely compact, the unit is skid-mounted and self-contained, with its own cooling system. Low maintenance cost, high mobility and flexibility of the packaged unit are important features of the new compressor.

(This item supplements Schramm, Inc., data on Pages 4414-4415 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E18** on Readers' Service Card, last page this issue.

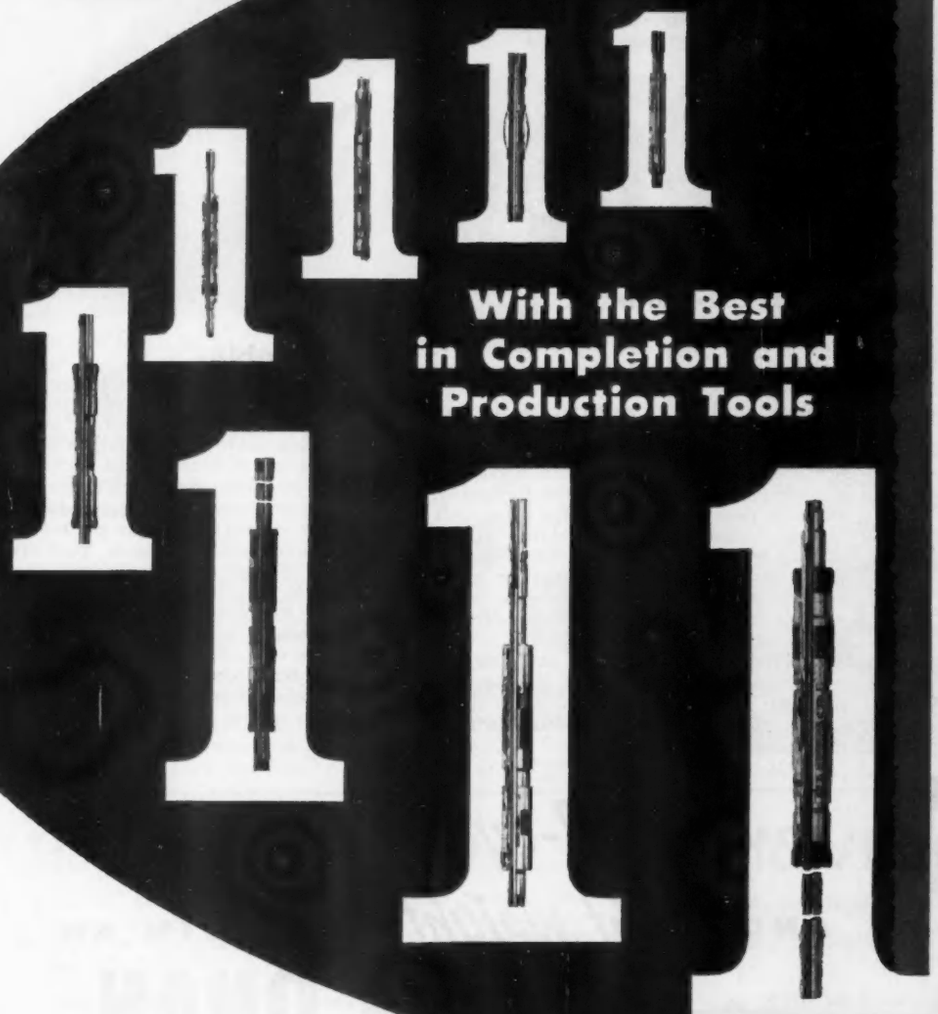
Drilling Mast

A guyless cantilever drilling mast made of lightweight tubular columns instead of conventional lattice-type girts and braces is being manufactured by Haniel & Lueg GMBH, Dusseldorf, Germany. This cylindrical shell construction provides increased stiffness, permitting the mast to handle larger crown loads This type structure also provides increased shock absorbing properties, reducing the possibility of mast damage due to be struck by the traveling block. Good transportability, easy assembly and safe operations are other features.

Haniel & Lueg is building the "Gulliver" mast in two models; one 138 feet high with a safe load capacity of 900,000 pounds, and the other 133 feet high with a safe load capacity of 1,000,000 pounds.

The mast consists of two column-type main legs, each made up of three sections that are connected by positive quick-action flange connections. Taper seats facilitate the make-up. Legs are rigidly connected by the bolted crown block assembly and are braced toward the drawworks by struts. The mast is assembled at ground

Always first



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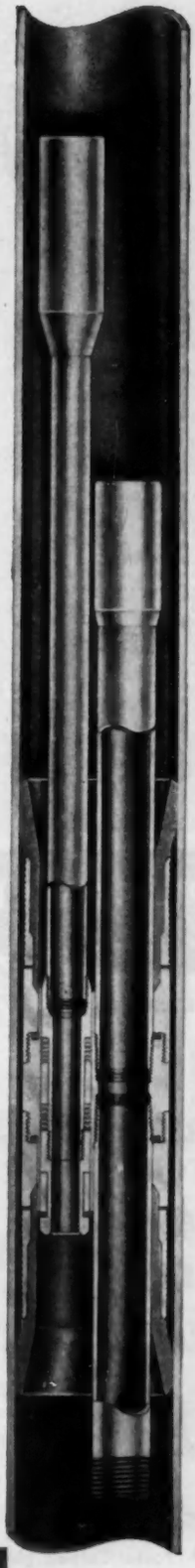

For twenty-five years Brown Oil Tools has produced the completion and production equipment the petroleum industry needs. As new needs arise Brown research is with, or ahead of, the industry in development and testing of the equipment that will do the job and do it right.

The tools shown above—The Zone Selector—The Boll Weevil Liner Hanger—The Casing Patch Tool—The B-4 Packer—The SOS J-7—The Duo-Pak Packer—The BP-4—The RS-1—are representative of the Brown line of tools. Each tool was developed to meet a particular need for the industry.

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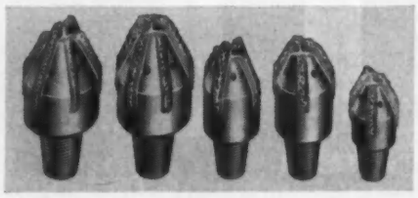
level, then pulled upon the substructure over guide tracks. Inclination of the mast may be adjusted in any direction by about six inches.

(This item supplements Haniel & Lueg G.M.B.H. data on Pages 2221-2234 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E19** on Readers' Service Card, last page this issue.



Initial Cut-out Mills

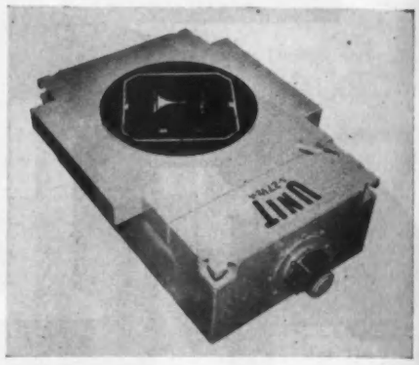
Servco has added CP mills to the line. The new CP mills are primarily used to make the initial cut-out in drain hole drilling; however, they are also used in a limber hook-up to side-track a liner or fish and in special milling work.

As with all Servco milling tools, the new CP mills are dressed with Servcoloy, a completely new and original method of utilizing tungsten carbide. Bits of carbide are suspended in a tough, elastic matrix so that hundreds of cutting edges are always in contact with the surface to be cut. As particles are worn or torn away, new cutting edges are automatically exposed.

Complete information on the new CP mill, as well as other Servco milling tools utilizing the Servcoloy process, is given in an eight-page brochure available from the manufacturer.

(This item supplements The Servco Co. data on Pages 4513-4524 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E20** on Readers' Service Card, last page this issue.



Rotary Table

A new 27½-inch rotary table has been added to Unit Rig's line of dependable equipment. Triple labyrinth mud seal and flinger rings make table mudproof. Handling lugs are designed with open ends for quick handling. Rectangular lines permit quick and easy flooring buildup.

Locking device works on perimeter of table, eliminating all shock loads from gear and pinion. Gears are spiral bevel lapped and matched for smooth performance and hardened to provide long life. Master bushing is locked in place with a single lock operated from top of the table.

(This item supplements Unit Rig & Equipment Co. data on Pages 4957-4988 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E21** on Readers' Service Card, last page this issue.

COOPER-BESSEMER *uses...*

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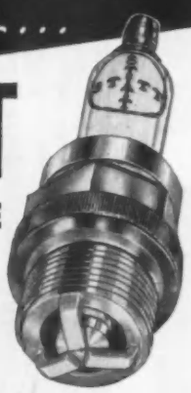
NEW TRIPLE IGNITOR SPARK PLUGS



. . . to get peak performance longer, Cooper-Bessemer is now factory-installing STITT New Triple Ignitor Spark Plugs. STITTS last up to 10 times longer, cut downtime, increase magneto life. Also factory equipment in other leading oil field engines.

Write today for FREE Pocket Catalog giving recommended plugs for all your engines—help you get better plug performance.

STITT IGNITION CO.
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STITT MAKES HEAVY-DUTY, INDUSTRIAL-TYPE PLUGS!

YOU GET *4-cycle* DEPENDABILITY AND *Light weight* TOO . . . IN AN

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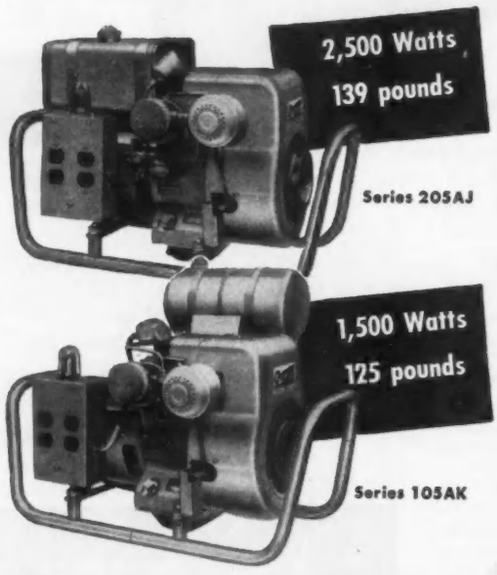

These power-packed electric plants give you all the *4-cycle* advantages of quick starting, long life and trouble-free operation . . . with an amazing weight saving over usual 4-cycle plants. You can carry them easily to any spot . . . and you can count on them delivering their full rated capacity as long as you need it. Both are single-cylinder, air-cooled . . . completely equipped and ready to go.

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Sol-Treet makes paraffin problems a thing of the past!

As you know, I had tried everything to dissolve my down-hole paraffin, with no results. The well was making from 3 to 5 barrels a day. As a result of your Sol-Treet the tubing and flowlines are free of paraffin and the well is now making 30 barrels a day.

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Production Supt.
Paco Petroleum Corp.
Mt. Carmel, Illinois

The above excerpt from an unsolicited letter is a typical Sol-Treet success story. Sol-Treet has been field-proven effective in stopping paraffin problems. Excellent results are being obtained in use in pumping and flowing wells, recycling, lead lines, and breaking out and dissolving BS and paraffin in tank bottoms. Available at most supply stores, or contact

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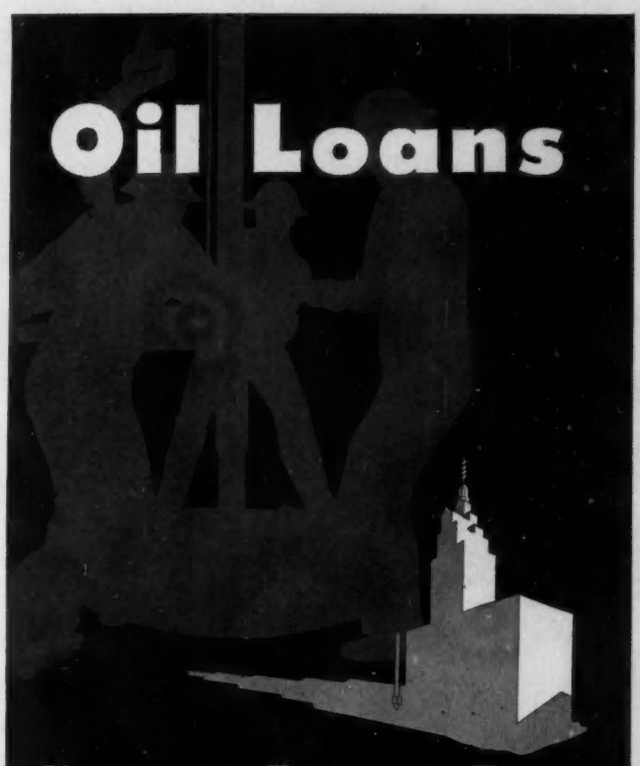

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  by Joseph Zaba and W. T. Doherty — Price $14.00
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Christmas Tree Roots

Who can say when and where an idea is born? Creative design engineers don't work by the clock. Their scratch pad is more often the back of a napkin or a scrap of paper. They think and talk shop all the time.

Perhaps these engineers are talking about last weekend's catch.

Fishing conditions in the Gulf of Mexico have nothing to do with the Oil Center Tool Company necessarily, or Christmas Trees.

But the point is, tomorrow's coffee break may see these same scientists discussing an idea. It will be an idea that someday may have a direct bearing on how you will complete your well or produce your oil and gas.

Christmas Trees aren't born in a machine shop . . . they're born in the minds of men.

That's why the Oil Center Tool Company places so much emphasis on minds . . . that's why O-C-T emphasizes research and engineering.

Roots of O-C-T trees go deep—miles into the earth, as a matter of fact.

But, there is another depth which is the real reason for the stability of O-C-T—depth of research and development.

The need for efficient, economical well control equipment stamped "O-C-T" that is being used so widely in the oil patches today was anticipated long before that need became critical.

The idea for much of this equipment was born . . . the seed sown . . . perhaps at a coffee break.

But, ideas aren't transmitted directly to the machine shop.

These have a long gestation period.

Many months of laborious paper work, model experimentation and testing are necessary before an O-C-T product makes its debut in an oilfield.

Design must be right . . . the product must be right.

O-C-T has pioneered many improvements, many completely new designs, in the area of well control equipment. The company's list of "firsts" is long.

This "first thirst" that is part of the spirit of O-C-T is always being slaked by experienced engineers . . . by imaginative researchers . . . by practical development men.

These men know the oil industry. They know its problems.

More than that, they have the ability to plan for the future, to anticipate problems of tomorrow.

The best in oilfield equipment is being turned out in O-C-T shops.

And the best in oilfield equipment to solve difficult problems in the future is being turned over in the minds of men . . . being charted on design boards.

Seeds originate at O-C-T.

And they're sown there . . . cultivated there.

The harvest is yours!

O·C·T

OIL CENTER TOOL CO.

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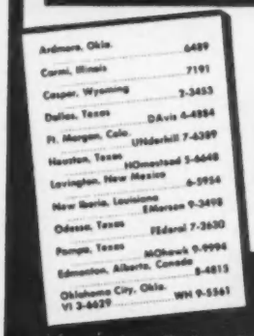

GOOD SERVICE NEAR YOU

There's a BRAKESOL Treating Engineer near you who can show you the most effective methods of application to solve your paraffin problem . . . in one easy operation. Contact him TODAY, he'll be glad to help you. For additional information, write us direct, or contact your local supply store.

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To establish conclusive proof of the accuracy of our geophysical work, we will, without cost to you, test and record a log of your well on tape, bearing your signature and ours, of your rank wildcat location, in advance of drilling, indicating the existence or not of petroleum in commercial quantities underlying the tested areas and approximately at what depth it may be found. The instruments are entirely self-operating during testing period.

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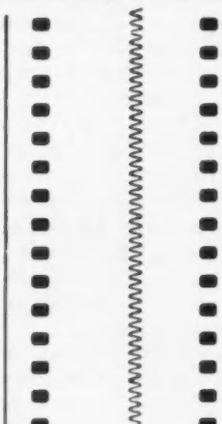

Specimen of log tape indicating saturation with break in zone

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New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Hardfacing Bulletin

Spangweld and Spang Double Seal Shrink Thread drill pipe and tool joints are presented in a new 24-page illustrated booklet, Bulletin No. 463, by National Supply Company, Pittsburgh.

A new type of hardfacing for Spang tool joints is announced in this bulletin, including full details on hardfacing specifications and application methods. In addition to complete specifications on tool joints for drill pipe, the bulletin covers tubing tool joints and gives 21 suggestions for the care and maintenance of all kinds of tool joints.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Tractor Attachment Book

How addition of the right tractor job attachment increases production and profit on virtually all types of construction and logging operations is covered in an informative 8-page catalog offered by Hyster Company. All Hyster tractor job attachments offer the advantage of Caterpillar-built tractor mobility and maneuverability combined with the extensive power of Caterpillar diesel engines.

Shown in the catalog are the complete line of tractor-mounted accessories for Caterpillar-built tractors, including heavy-duty towing winches, worm drive winches, hyspeed winches, oil well servicing winch and the Hyster donkey hoist and Hyster yarder. Also presented is the Hyster developed and exclusive tractor-mounted Hystaway excavator-crane which can be equipped as a dragline, clamshell, crane, pile driver, shovel or backhoe.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Industrial Pump Pamphlet

A new booklet on verti-line close-coupled industrial pumps is made available by Layne & Bowler Pump Company of Los Angeles. Easy to use table for determining horsepower, capacity and head for vertical pumps makes this bulletin worth keeping. It also contains sectional views, material specifications, schematic application drawings and photos of installations. Verti-Line Pump features are clearly illustrated.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

Arc Welding Catalog

A new arc welding machine and accessory catalog is now available from Air Reduction Sales Company.

Selenium rectifier and DC motor generator arc welders for industrial welding, AC and DC engine driven arc welders for construction and maintenance, AC transformer arc welders for plant, farm, ranch, garage and shop use are examples of the complete Airco line of welding machines illustrated and described in this catalog. Specifications for each machine, from ampere ratings to outside dimensions, are included.

To get a copy, circle **No. E25** on Readers' Service Card, last page this issue.

Pathfinder Tool Booklet

An eight-page catalog covering the complete line of Pathfinder oil well tools has been made available by the sole distributor of these products, Oil Country Equipment Company, Houston. The Pathfinder line includes specially designed hinged, rotatable, and close tolerance-type centralizers, as well as a grip collar and a unique tool for the removal of undesirable materials from the walls of wells to permit a better bonding of cement to the formation. The latter, a well bore wiper, is available in three models—a no-weld, standard and circular type. Tests, data, engineering facts, as well as price lists, are also included in this brochure.

To get a copy, circle **No. E26** on Readers' Service Card, last page this issue.

Bulk Equipment Brochure

A 12-page catalog covering the complete line of bulk handling equipment and correlated equipment, with special fabrications in that line, is available from Rig Engineers and Fabricators Co., Inc. Standard bulk cement, mud and sandfrac plants, both stationary and portable, are shown, as well as bulk commodity trailers and bulk truck units. Dry mud and cement storage bins and feeders are included with a number of special items in the drilling field.

To get a copy, circle **No. E27** on Readers' Service Card, last page this issue.

Diesel Unit Brochure

Detroit Diesel's complete line of two-cycle power units for the oil fields are fully described and illustrated in a 16-page brochure just released. Covered are the Division's new Turbopower models, Diesel-Electric sets, single and multiple-engine units from 60 to 762 horsepower. Also covered are torque converter models and marine propulsion units for craft servicing offshore operations.

To get a copy, circle **No. E28** on Readers' Service Card, last page this issue.

Rotary Rig Literature

Extreme portability and speed of the Model 35 rotary drill rig are explained in a new bulletin issued by Joy Manufacturing Company. The bulletin features field photographs and complete specifications illustrating the flexibility of the Joy Thirty-Five as a geophysical shot hole or shallow water well rig.

Mounted on a short wheel base truck, the Thirty-Five can get in, rig up and start drilling in minimum time. Though the Thirty-Five is the smallest Joy portable rig, it has many features of larger machines, including four rotary speeds forward for combined speed and economy.

To get a copy, circle **No. E29** on Readers' Service Card, last page this issue.

Industrial Engine Sheet

A specification sheet giving power curves, design details, engineering features and installation drawings for the new high torque, heavy duty Jeep-6 is available.

To get a copy, circle **No. E30** on Readers' Service Card, last page this issue.

Aluminum Corrosion Book

A new and more convenient guide to engineers in determining the corrosion resistance of aluminum has been published by Reynolds Metals Company. Titled "Corrosion Keys for Aluminum," the brochure is intended primarily as an aid to engineers designing aluminum into process plants or equipment, although it will be of interest to those concerned with other applications of the metal.

The proper use of aluminum, it points out, can help enormously in reducing the annual $6 billion loss caused American industry by rust and corrosion. The brochure makes extensive use of graphs which tell at a glance the yearly corrosion rate of more than 100 chemicals and other corrosive materials on aluminum.

To get a copy, circle **No. E31** on Readers' Service Card, last page this issue.

Gas Drilling Engine Info

Bulletin 103 features the Model 6G-510 Superior gas drilling engine developed by White Diesel Engine Division of the White Motor Company. Power for all oil field jobs, the four-cycle, six cylinder engine is distinguished by simplicity of design and heavy duty construction.

The engine conservative horsepower rating assures adequate reserve power for extra capacity loads, for hoisting and fast acceleration for easy pipe handling.

The colorful bulletin shows specifications, dimensions, performance curves and diagrams the engine's optional power take off.

To get a copy, circle **No. E32** on Readers' Service Card, last page this issue.

Dowell Fracturing Additive

A new pamphlet describing Gypban, Dowell's new fracturing additive is available. It affords lasting protection from formation-plugging gyp. It is also a safeguard against rapid declines after fracturing.

To get a copy, circle **No. E33** on Readers' Service Card, last page this issue.

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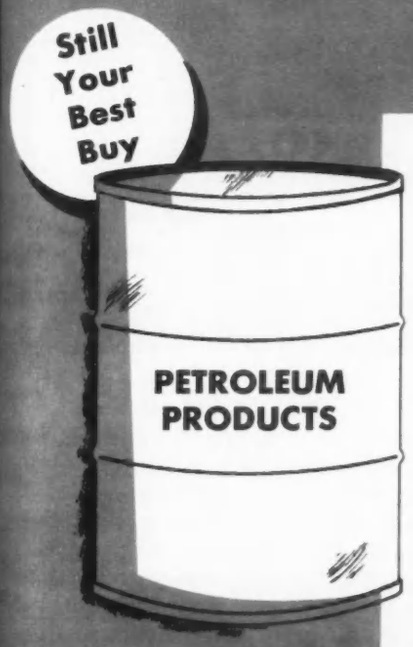
A supplement to WORLD OIL, March, 1957

The Facts About Oil Prices

...America's Biggest Bargain



Unfair, garbled and misleading statements followed the higher crude oil and gasoline prices posted early this year. The American public is entitled to the true facts about oil prices. After all, Mr. and Mrs. America are buyers of oil products.

While other industries have raised prices every year or oftener, there have been only two oil price advances in nine years. Oil price increases have been small compared with other commodity prices.

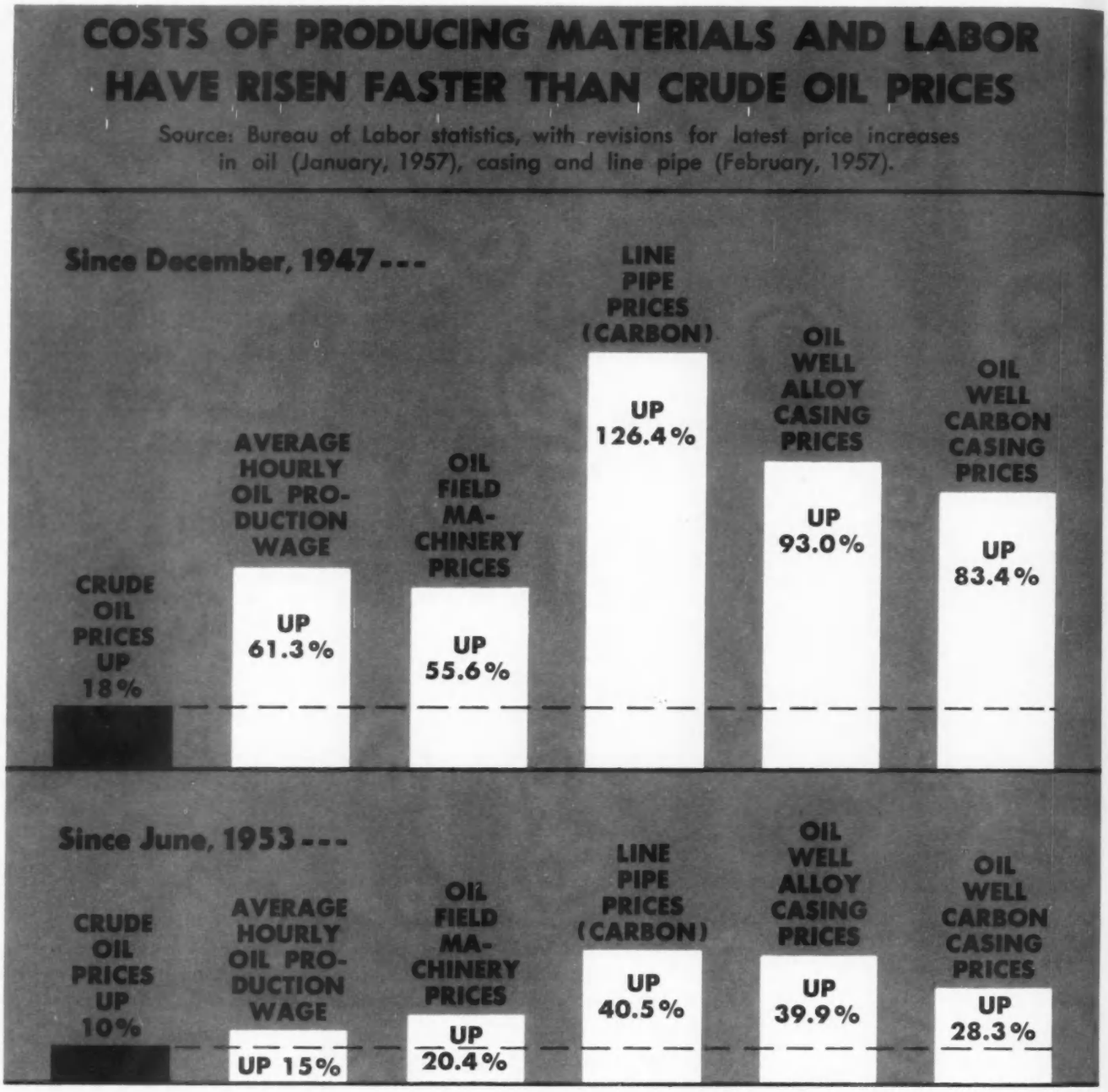
Mr. and Mrs. America still pay less for gasoline than for milk, soft drinks and many other items, although taxes constitute one-third of the price they pay for gasoline.

Oil is not the fabulously rich industry many believe. Oil earns a lower rate of return on capital invested than many other industries, and oil's return has declined while other returns have risen.

Like other businesses, oil costs have risen sharply. It is an expensive business, requiring tremendous investment. Profit rates must be adequate to attract huge investment capital. Otherwise Mr. and Mrs. America's best buy will cease to exist.

Here are the facts about oil prices . . .

Prepared for Gulf Publishing Company
Publishers of WORLD OIL, PIPE LINE INDUSTRY and PETROLEUM REFINER
By Warren L. Baker and Cecil W. Smith


COSTS OF PRODUCING MATERIALS AND LABOR HAVE RISEN FASTER THAN CRUDE OIL PRICES
Source: Bureau of Labor statistics, with revisions for latest price increases in oil (January, 1957), casing and line pipe (February, 1957).
Since December, 1947 ---
CRUDE OIL PRICES UP 18%
AVERAGE HOURLY OIL PRODUCTION WAGE
UP 61.3%
OIL FIELD MACHINERY PRICES
UP 55.6%
LINE PIPE PRICES (CARBON)
UP 126.4%
OIL WELL ALLOY CASING PRICES
UP 93.0%
OIL WELL CARBON CASING PRICES
UP 83.4%
Since June, 1953 ---
CRUDE OIL PRICES UP 10%
AVERAGE HOURLY OIL PRODUCTION WAGE
UP 15%
OIL FIELD MACHINERY PRICES
UP 20.4%
LINE PIPE PRICES (CARBON)
UP 40.5%
OIL WELL ALLOY CASING PRICES
UP 39.9%
OIL WELL CARBON CASING PRICES
UP 28.3%

Crude oil prices have not kept pace with the price gains of major elements in production costs. They remain low in comparison with the costs of labor and materials used by the industry.

Since 1947, there have been only two general increases in U. S. crude oil prices. A 25-cent per barrel increase took place in June, 1953, and the other, which also averaged about 25 cents a barrel, in January, 1957.

Neither of these was adequate to cover increases in the cost of finding, developing and producing crude oil. Crude oil prices today are only 18 percent above 1947, whereas prices of major elements in production costs have risen three to six times faster. The 10 percent increase in crude prices during January, 1957, did not cover all the increases in prices that have taken place since 1953.

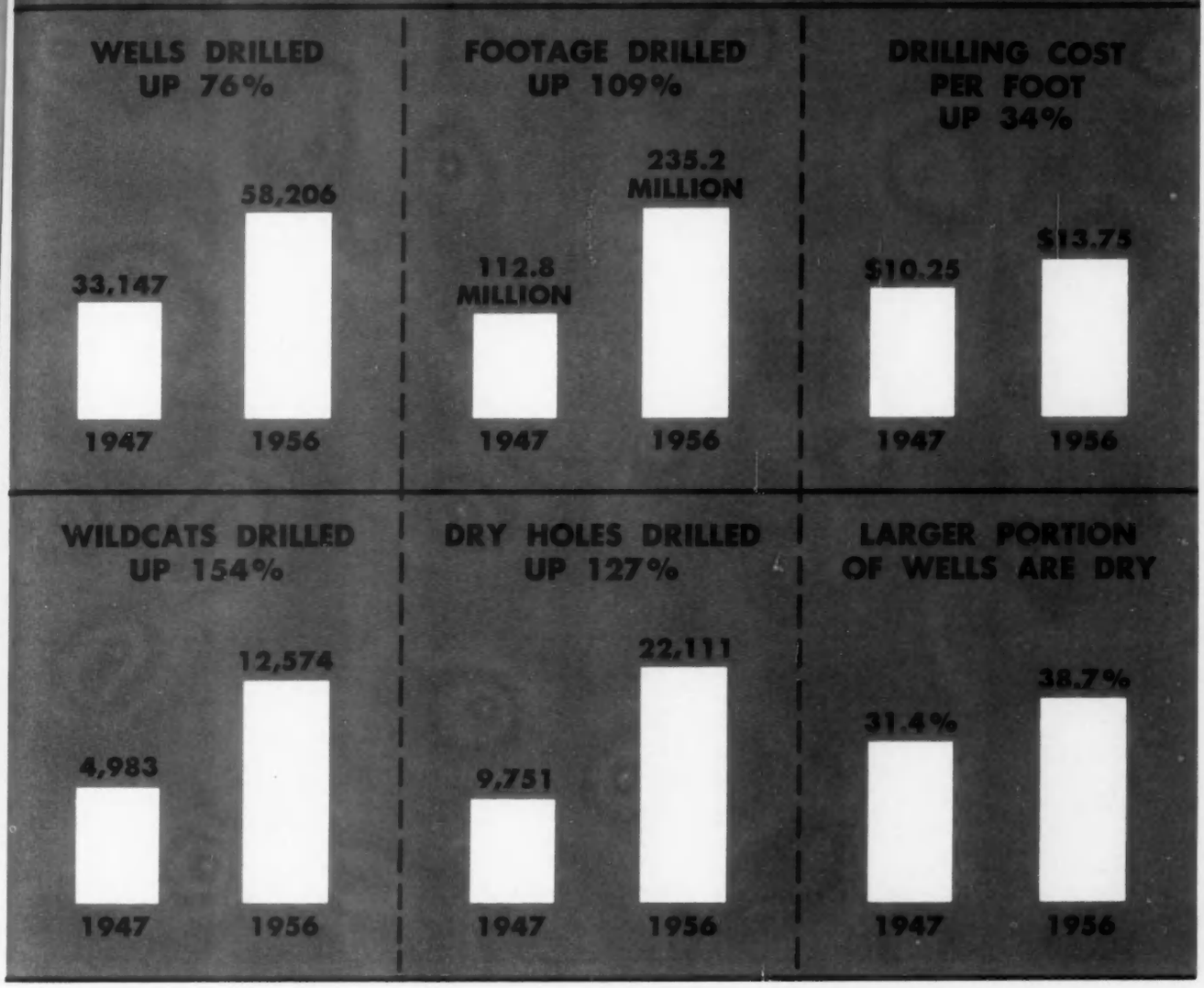
For example, the 18 percent increase in crude oil prices since 1947 compare with an increase of 61 percent in average hourly wages paid by the industry, while oil well casing has risen from 83 to 93 percent, line pipe by 126 percent, and oil field machinery by 55 percent.

Wages and steel are the two principal cost items to the oil industry. The industry uses large quantities of steel, metal and machinery, particularly in the production end of the business. It requires an average of 80 tons of steel for each new well drilled: In contrast, the average automobile requires less than two tons of steel. Yet motor vehicle prices are up 46 percent since 1947 in contrast with a gain of 18 percent for crude oil.

If this vital industry is to keep America supplied with increasing quantities of oil, it must be permitted to remain in a strong, healthy position—the price received for its product must reflect increased production costs.

FACTORS BESIDES MATERIALS AND LABOR HAVE ADDED TO OIL'S COSTS SINCE 1947

Source: Drilling cost per foot from American Association of Oilwell Drilling Contractors. Other data from WORLD OIL, February 15, 1957, Forecast-Review Issue.



In addition to higher materials and labor costs, other factors also have added greatly to the cost of finding and producing oil in the U. S.

The search for oil is big business, calling for the drilling of many wells annually to locate and develop sufficient new producing fields to satisfy the rapidly expanding use of petroleum.

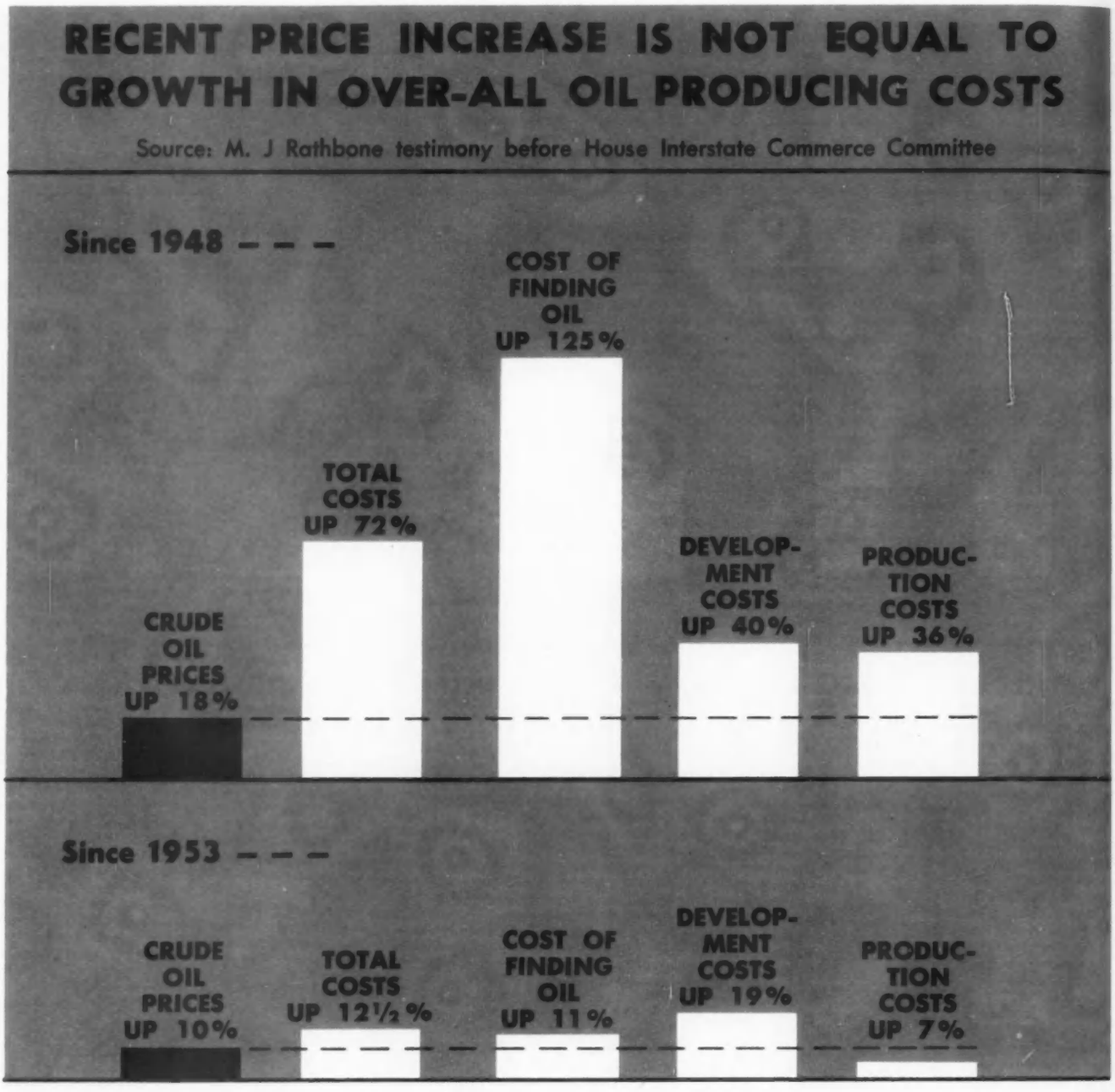
To provide enough oil to satisfy Mr. and Mrs. America's 62 percent increase in demand for petroleum products since 1947, the industry has had to greatly accelerate its expenditures for drilling operations. Between 1947 and 1956 the number of wells drilled annually increased by 76 percent. Due to greater depths of wells, footage advanced even more rapidly, rising 109 percent. Footage is a truer index of expenses, costs rising sharply with depth.

To find enough oil to satisfy rising demand, the industry has nearly tripled the number of "wildcat" tests. These are wells drilled in unproven areas seeking to discover new producing fields. Wildcats constituted 22 percent of all wells drilled in 1956, in contrast with only 16 percent in 1947.

Terrific financial odds are involved in the drilling of wildcats. Here is where many an oil man loses his pants as well as his shirt. Eighty-eight percent of all wildcats drilled invariably fail to find production—only 1 out of 9 ever produce any oil or gas. They are complete financial failures.

Increased wildcatting resulted in the drilling of 2¼ times more dry holes during 1956 than in 1947. This resulted in 38.7 percent of all wells drilled (wildcat and field development wells) being dry holes during 1956, whereas less than 30 percent were dry prior to 1946.

All these factors have tended to add greatly to the cost of finding and producing oil in the U. S.


RECENT PRICE INCREASE IS NOT EQUAL TO GROWTH IN OVER-ALL OIL PRODUCING COSTS
Source: M. J Rathbone testimony before House Interstate Commerce Committee
Since 1948 – – –
CRUDE OIL PRICES UP 18%
TOTAL COSTS UP 72%
COST OF FINDING OIL UP 125%
DEVELOP-MENT COSTS UP 40%
PRODUC-TION COSTS UP 36%
Since 1953 – – –
CRUDE OIL PRICES UP 10%
TOTAL COSTS UP 12½%
COST OF FINDING OIL UP 11%
DEVELOP-MENT COSTS UP 19%
PRODUC-TION COSTS UP 7%

Oil production costs have risen more than crude oil prices since World War II. Even after the January, 1957, increase crude oil prices did not equal the growth that has occurred in costs. Higher costs indicate oil price increases were long overdue.

Because of the many factors discussed on the preceding two pages, total production costs advanced 72 percent between 1948 and 1956, and by 12½ percent between 1953 and 1956. Even with the January, 1957, increase, crude oil prices were only 18 percent above 1948, and but 10 percent higher than in 1953. These are 1957 oil prices compared with 1956 oil costs.

Further increases in production costs will occur in 1957. Early February price advances for oil well casing and line pipe may add as much as $40 million to the industry's operating costs in 1957.

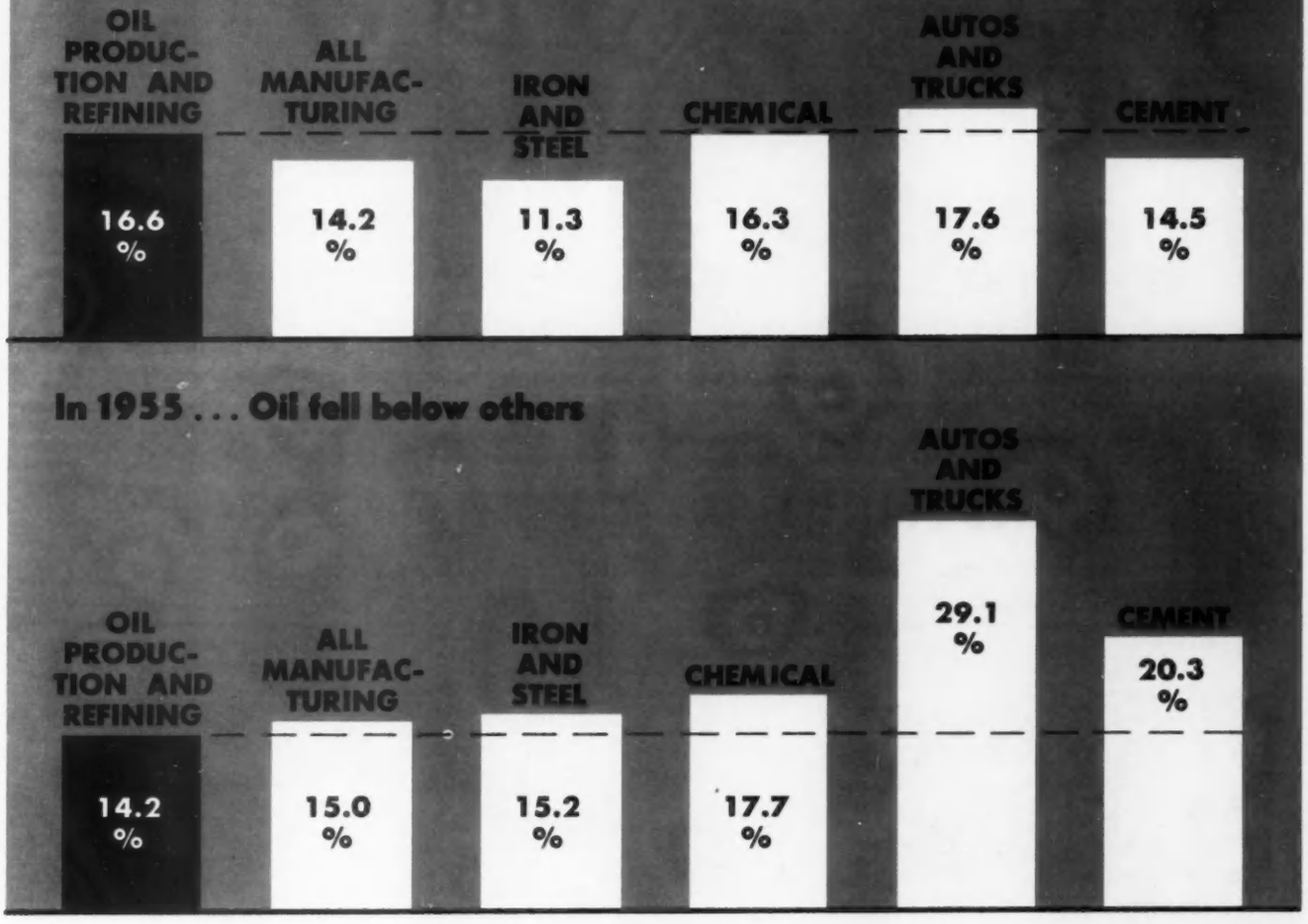
A particularly large increase in the cost of finding oil occurred between 1948 and 1956. A growth of 125 percent was recorded. This big gain was due to the increased number of wildcats drilled and the growing number of dry holes drilled, as well as higher wages and prices of casing and machinery.

Finding new producing fields is the industry's big risk—the operation that makes it different from any other business. Prices must be adequate to provide ample incentive, or men will not risk huge sums at 1-out-of-9 odds.

Unless wildcatting is maintained at high rates, the nation's oil producing ability would soon shrink below needs. The output of oil wells inevitably declines gradually as they become older. America's high consuming rate requires the discovery of over 4 billion barrels of new oil each year.

RATE OF RETURN ON CAPITAL INVESTMENT HIGHER IN OTHER INDUSTRIES THAN IN OIL

Source: First City National Bank of New York Monthly Letter.
Data based on leading corporations in each industry.



Oil is not the fabulously profitable business so many consider it to be. Many other businesses earn a higher rate of return on capital investment.

Furthermore, failure of oil prices to keep pace with rising costs has meant decreasing profit margins in recent years while returns of other industries have increased. The rate of return on investment by leading oil companies has never been out of line with that of other business and in recent years has been quite moderate in comparison with other industries.

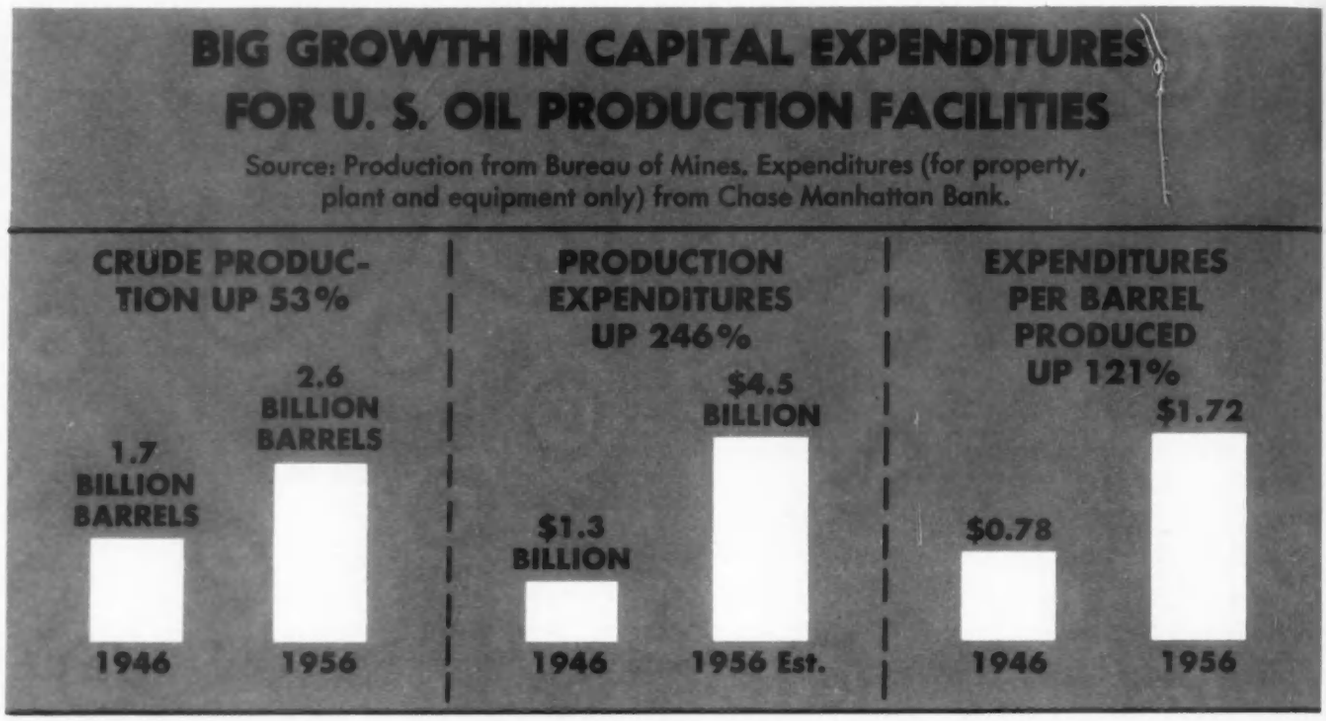
In net return on net assets the oil industry is behind such businesses as iron and steel, chemical products, motor vehicles, all manufacturing industries and others.

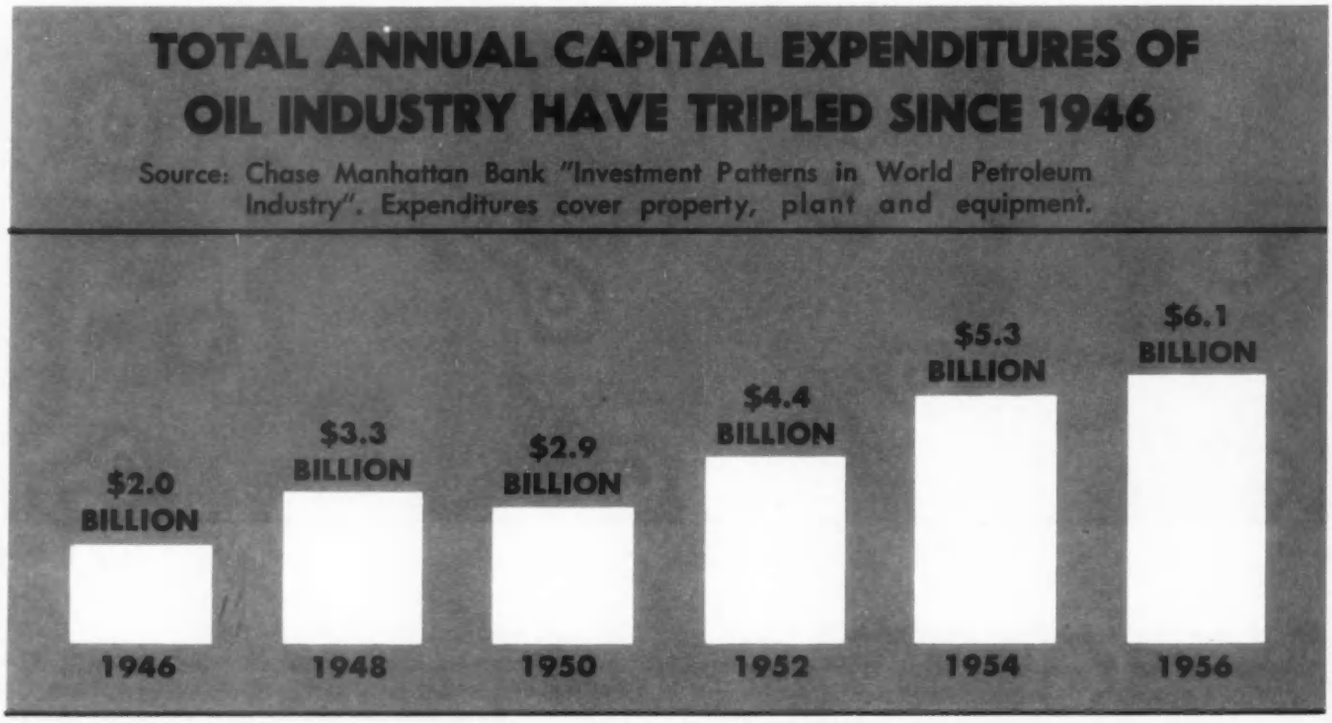
Ninety-two leading U. S. petroleum producing and refining corporations, including those with large foreign holdings as well as domestic, had a return of 14.2 percent on their net assets in 1955, latest year available. This compared with a 16.6 percent in 1951.

Rising costs without corresponding increases in prices have cut down net returns on oil investment. Because of greater risks in oil producing operations, the oil industry should enjoy higher rates of return than other businesses.

In contrast, manufacturing, iron and steel, chemicals, autos and trucks, cement and other industries had higher return rates on their investments in 1955 than in 1951. Some were up by substantial amounts. The automobile industry, for example, had a net return of 29.1 percent in 1955 compared with 17.6 percent in 1955.

Mr. and Mrs. America hear of the few oil men who are fortunate enough to hit a bonanza. But they never hear of the thousands of oil men who struggle throughout their lives to make ends meet, nor of those who lose vast sums of money hoping to find an oil field.





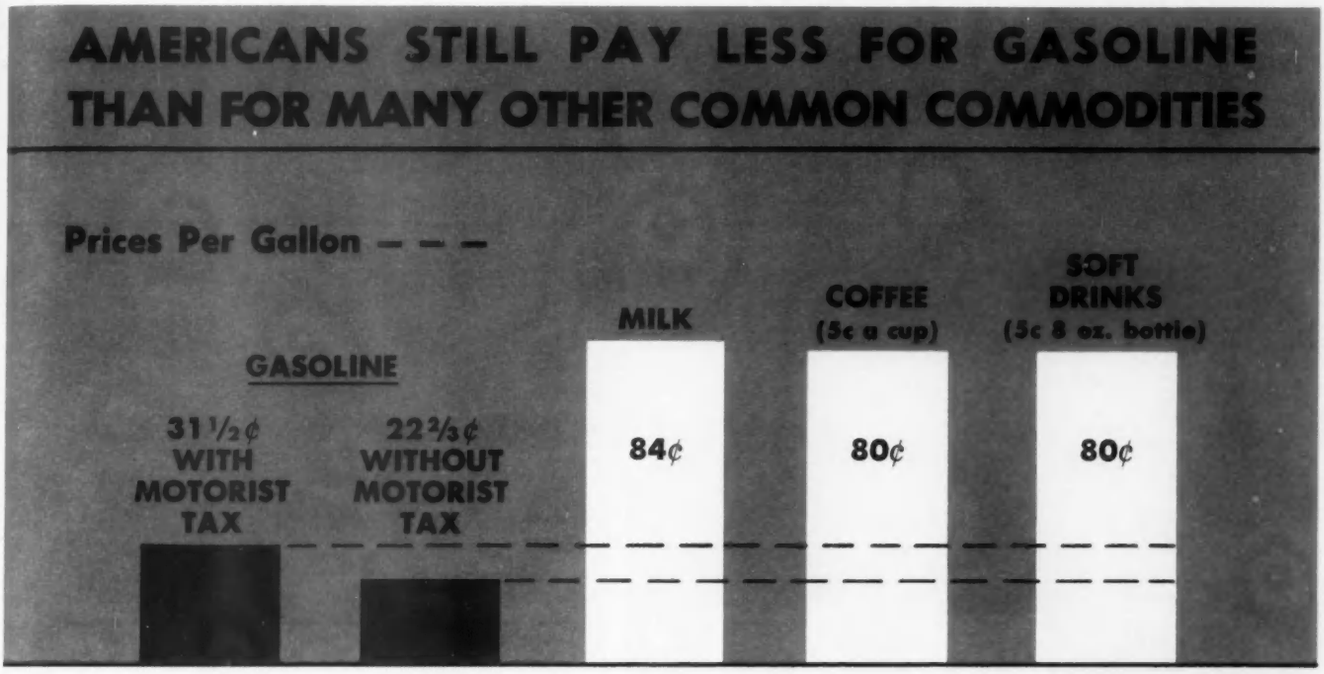
Oil is an extremely expensive business. Huge capital investment is required to provide enough oil to meet expanding U. S. civilian and industrial requirements.

Total annual petroleum capital expenditures in the U. S. (for property, plant and equipment only) have risen sharply in recent years. They reached the staggering sum of $6.1 billion during 1956, three times larger than in 1946. Most of this investment was in producing operations.

Since World War II capital investment in U. S. oil has totaled $44.2 billion. No other industry has matched this investment rate. Oil now ranks as one of the largest industrial activities in the nation.

It is highly important that oil have an adequate profit level. Chase Manhattan Bank has estimated $51 billion will need to be invested during the next ten years to keep America supplied with oil. There would be no hope that a sum of such magnitude could be generated internally or be attracted from outside investors unless the industry's prices keep pace with rising costs.

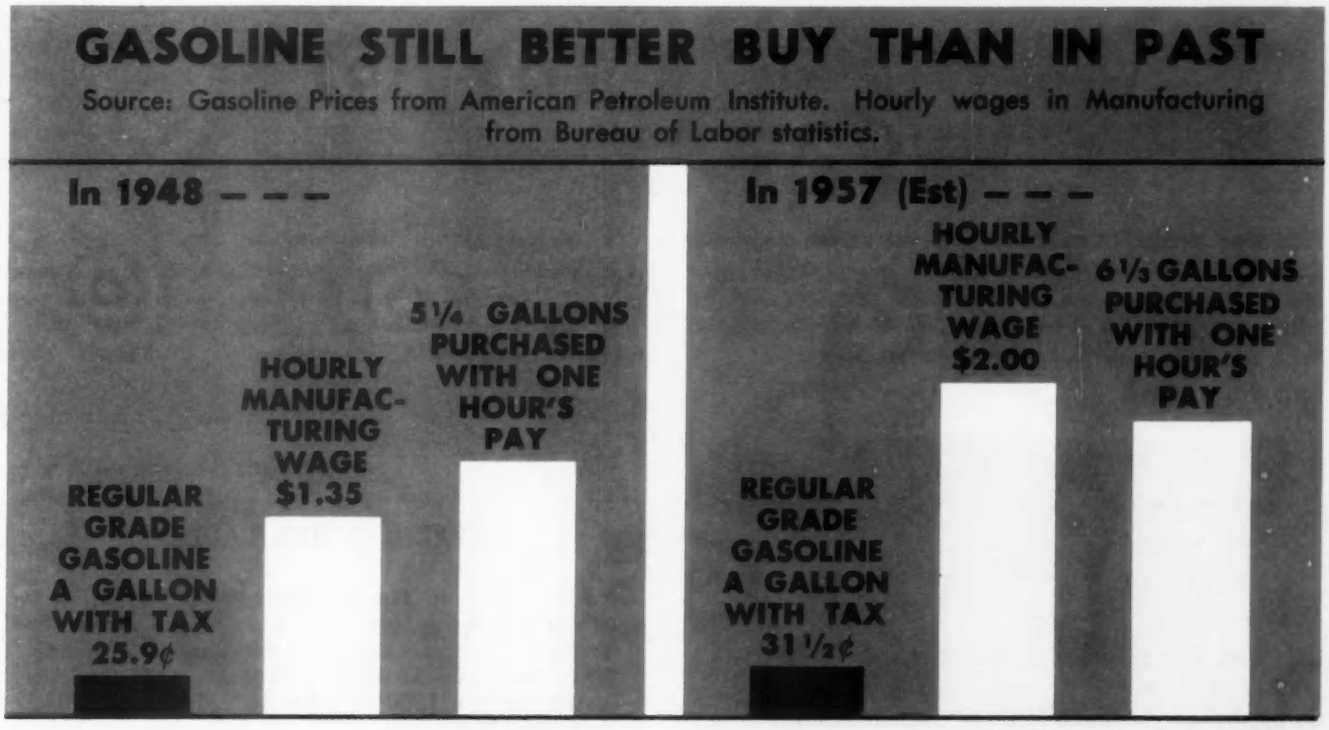
The recent Suez crisis has demonstrated dramatically that adequate domestic oil supplies are vital to America's security. America must have oil. It operates on oil.



Gasoline Is Still Cheap. It is still America's biggest bargain. Such items as milk, coffee and soft drinks retail for about 2½ times more than gasoline. This is true today, even after the recent gasoline price advance.

Mr. and Mrs. America pay an average of 31½ cents a gallon for regular grade gasoline today. However, state and federal motorist taxes make up nearly 9 cents of this amount. But even with taxes included, gasoline is cheap, costing only 2 cents per mile traveled.

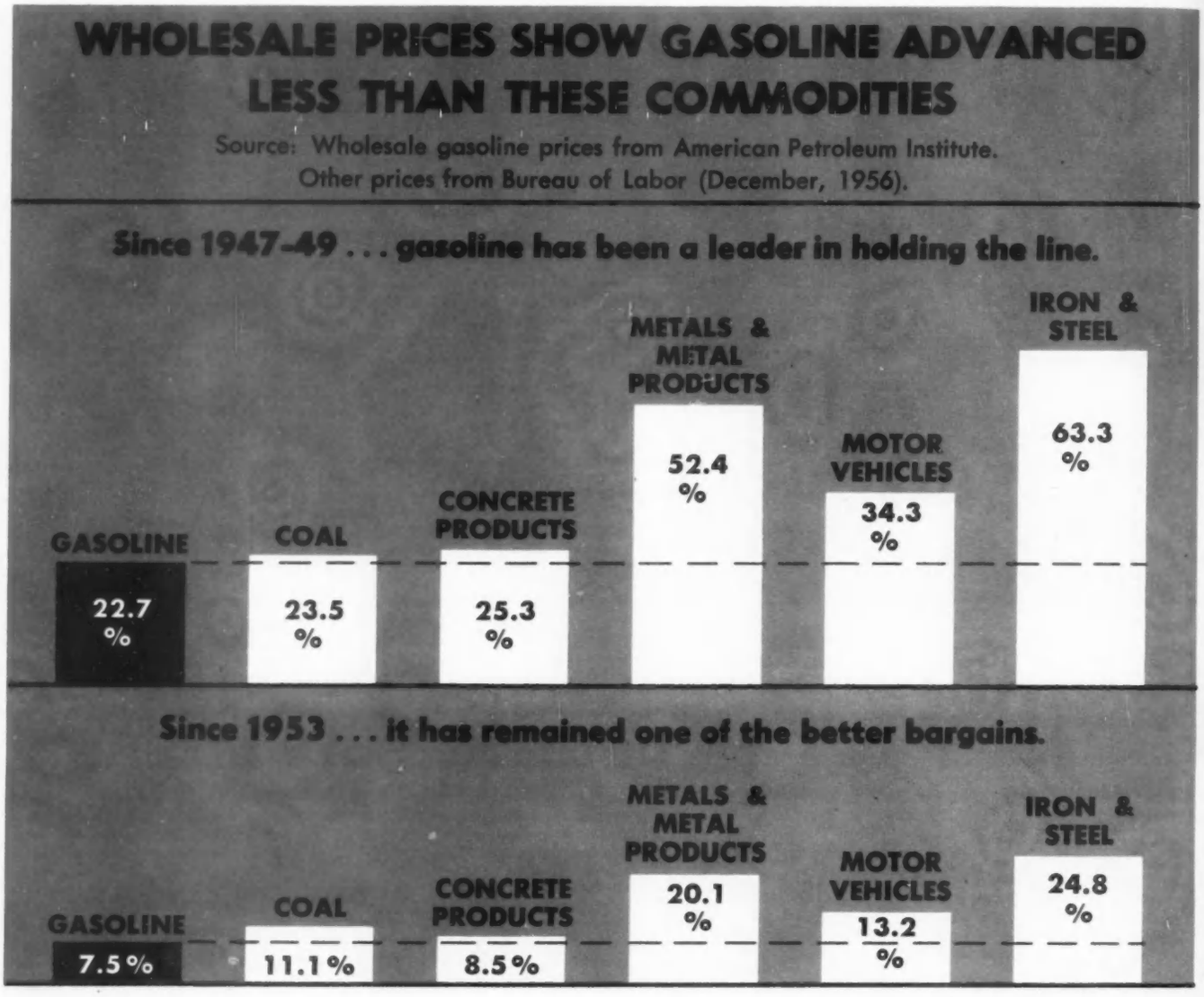
Gasoline weighs approximately 6 pounds a gallon, hence sells for 5⅓ cents per pound including taxes. What else sells for so little these days?


GASOLINE STILL BETTER BUY THAN IN PAST
Source: Gasoline Prices from American Petroleum Institute. Hourly wages in Manufacturing from Bureau of Labor statistics.
In 1948 — — —
REGULAR GRADE GASOLINE A GALLON WITH TAX 25.9¢
HOURLY MANUFAC-TURING WAGE $1.35
5¼ GALLONS PURCHASED WITH ONE HOUR'S PAY
In 1957 (Est) — — —
REGULAR GRADE GASOLINE A GALLON WITH TAX 31½¢
HOURLY MANUFAC-TURING WAGE $2.00
6⅓ GALLONS PURCHASED WITH ONE HOUR'S PAY

Gasoline takes a smaller portion of U. S. workers' pay today than in the past. More gasoline can be bought today with an hour's pay. Furthermore, the quality of gasoline is far superior to earlier years.

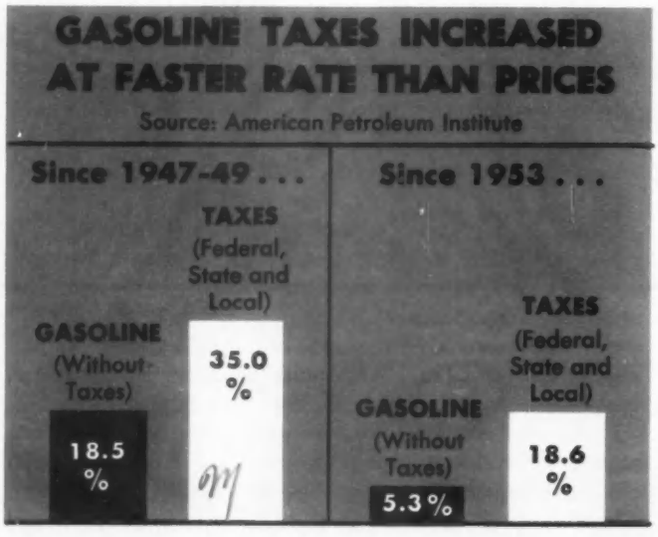
The average hourly wage of manufacturing employes, for example, will buy 6⅓ gallons of gasoline in 1957. Their hourly pay in 1948 would purchase only 5¼ gallons. These costs include all state and federal taxes.

If it were not for high motorist taxes, manufacturing employes could buy nearly 9 gallons of gasoline in 1957 with each hour's pay in contrast with slightly less than 7 gallons in 1948.


WHOLESALE PRICES SHOW GASOLINE ADVANCED LESS THAN THESE COMMODITIES
Source: Wholesale gasoline prices from American Petroleum Institute.
Other prices from Bureau of Labor (December, 1956).
Since 1947-49 . . . gasoline has been a leader in holding the line.
GASOLINE 22.7 %
COAL 23.5 %
CONCRETE PRODUCTS 25.3 %
METALS & METAL PRODUCTS 52.4 %
MOTOR VEHICLES 34.3 %
IRON & STEEL 63.3 %
Since 1953 . . . it has remained one of the better bargains.
GASOLINE 7.5%
COAL 11.1%
CONCRETE PRODUCTS 8.5%
METALS & METAL PRODUCTS 20.1 %
MOTOR VEHICLES 13.2 %
IRON & STEEL 24.8 %

Gasoline prices have risen less than most commodities. After the recent increase, wholesale gasoline prices are 22.7 percent above the 1947-1949 average, and 7½ percent above 1953. Few other commodities outside of farm products have had so small an increase.

Taxes have grown faster than the retail price of gasoline. Without taxes, retail gasoline prices are only 18.5 percent above the 1947-1949 average, while taxes are up 35.0 percent. Nevertheless, gasoline is still one of the biggest bargains in America today.


GASOLINE TAXES INCREASED AT FASTER RATE THAN PRICES
Source: American Petroleum Institute
Since 1947-49 . . .
GASOLINE (Without Taxes) 18.5 %
TAXES (Federal, State and Local) 35.0 %
Since 1953 . . .
GASOLINE (Without Taxes) 5.3 %
TAXES (Federal, State and Local) 18.6 %

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